

MATERIAL CULTURE
AND MODERN CONFLICT



Conflict Landscapes and Archaeology from Above



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Edited by

Birger Stichelbaut and David Cowley

CONFLICT LANDSCAPES AND ARCHAEOLOGY FROM ABOVE

The study of conflict archaeology has developed rapidly over the last decade, fuelled in equal measure by technological advances and creative analytical frameworks. Nowhere is this truer than in the inter-disciplinary fields of archaeological practice that combine traditional sources such as historical photographs and maps with 3D digital topographic data from Airborne Laser Scanning (ALS) and large scale geophysical prospection. For twentieth-century conflict landscapes and their surviving archaeological remains, these developments have encouraged a shift from a site oriented approach towards landscape-scaled research.

This volume brings together a range of perspectives, setting traditional approaches that draw on historical and contemporary aerial photographs alongside cutting-edge prospection techniques, cross-disciplinary analyses and innovative methods of presenting this material to audiences. Essays from a range of disciplines (archaeology, history, geography, heritage and museum studies) studying conflict landscapes across the globe throughout the twentieth century, all draw on aerial and landscape perspectives to past conflicts and their legacy and the complex issues for heritage management. Organised in four parts, the first three sections take a broadly chronological approach, exploring the use of aerial evidence to expand our understanding of the two World Wars and the Cold War. The final section explores ways that the aerial perspective can be utilised to represent historical landscapes to a wide audience.

With case studies ranging from the Western Front to the Cold War, Ireland to Russia, this volume demonstrates how an aerial perspective can both support and challenge traditional archaeological and historical analysis, providing an innovative means of engaging with the material culture of conflict and commemoration.

Dr Birger Stichelbaut is a post-doctoral researcher at the Centre for Historical and Archaeological Aerial Photography – a collaborative initiative between Ghent University, the In Flanders Fields Museum and the Province of West-Flanders – and is engaged with aerial photography, archaeology and the conflict landscape of the First World War. He is the author of the book In Flanders Fields: The Great War Seen From the Air and of several papers dealing with historical aerial photography and the archaeology of the Great War.

David Cowley is an archaeologist who manages the aerial reconnaissance programme at Historic Environment Scotland. He has published extensively on applications of historic aerial photographs, remote sensing for archaeology and aerial archaeology. His research is framed within landscape archaeology and includes conflict archaeology, methodology and sources. He is also undertaking part-time doctoral research at Ghent University.

Material Culture and Modern Conflict

Series Editors

Nicholas J. Saunders, University of Bristol, UK
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Modern industrial warfare remains a subject of huge interest to scholars, yet in order to fully comprehend this cultural phenomenon, it is important to look beyond narrowly defined narratives of causes, campaigns and outcomes. Building upon recent advances in the ability to conceptualise and understand the past, this new monograph series adopts a genuinely interdisciplinary approach to re-appraise the material legacy of war. By conceiving and studying the material culture of conflict, the series helps to construct biographies of objects, and explore their 'social lives' through the changing values and attitudes attached to them over time. In so doing books in the series demonstrate how objects can survive as expressions of 'war beyond conflict', revitalising meanings and creating new engagements between people and things.

The series offers a radical departure in the study of modern conflict – proving a truly interdisciplinary forum that draws upon, but does not privilege archaeology, anthropology, military and cultural history, art history, cultural geography, and museum and heritage studies. The complexity of modern conflict demands a coherent, integrated, and sensitised hybrid approach which calls on different disciplines where they overlap in a shared common terrain – that of the materiality of conflict and its aftermath. This approach has extraordinary potential to bring together the diverse interests and expertise of a host of disciplines to create a new intellectual engagement with the understanding of conflict.



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Contents

<i>List of Figures</i>	<i>vii</i>
<i>Notes on Contributors</i>	<i>xvii</i>
<i>Series Introduction: Material Culture and Modern Conflict</i>	<i>xxv</i>
<i>Series Editors' Preface by Nicholas J. Saunders and Paul Cornish</i>	<i>xxix</i>
 Introduction: Conflict Landscapes and Archaeology from Above	 1
<i>Birger Stichelbaut and David Cowley</i>	
 1 The Archaeology of World War I in Comines-Warneton (Belgium) through Aerial Photographs and Proximal Soil Sensing	 11
<i>Wouter Gheyle, Timothy Saey, Yannick Van Hollebeeke, Stephanie Verplaetse, Nicolas Note, Jean Bourgeois, Marc Van Meirvenne, Veerle Van Eetvelde and Birger Stichelbaut</i>	
 2 Bellewaarde Ridge (Belgium): Survey of a World War I Landscape	 29
<i>Marc Dewilde, Hilde Verboven and Franky Wyffels</i>	
 3 Contested Landscape: La Boisselle and the Glory Hole	 45
<i>Peter Masters</i>	
 4 World War I Remains in Scotland: Aerial Photography as Heritage	 59
<i>Allan Kilpatrick</i>	
 5 Protecting the Home Front: Understanding and Conservation of Twentieth-century Conflict Landscapes in England	 73
<i>Helen Winton</i>	
 6 Airborne Laser Scanning and the Archaeological Interpretation of Ireland's World War I Landscape: Randalstown Training Camp, County Antrim, Northern Ireland	 91
<i>Heather A. Montgomery and Rory W.A. McNeary</i>	

7	Aerial Perspectives on Archaeological Landscapes: The Anzac/Arıburnu Battlefields, Gallipoli, Turkey <i>Jessie Birkett-Rees</i>	109
8	Landscapes of Death and Suffering: Archaeology of Conflict Landscapes of the Upper Soča Valley, Slovenia <i>Dimitrij Mlekuž, Uroš Košir and Matija Črešnar</i>	127
9	The 'Gas-scape' on the Eastern Front, Poland (1914–2014): Exploring the Material and Digital Landscapes and Remembering Those 'Twice-Killed' <i>Anna Zalewska</i>	147
10	Remembering Uncertainty: The World War II Warscape of the Australian Northern Territory <i>Keir Reeves, Birger Stichelbaut and Gertjan Plets</i>	167
11	World War II Conflict and Post-conflict Landscapes in Northwest France: An Evaluation of the Aerial Photographic Resource <i>David G. Passmore, David Capps Tunwell and Stephan Harrison</i>	185
12	Mapping Unexploded Ordnance in Italy: The Role of World War II Aerial Photographs <i>Elizabeth Jane Shepherd</i>	205
13	Erased Landscapes: Conflict, Memory and Post-World War II Landscape Transformation in Western Poland <i>Grzegorz Kiarszys</i>	219
14	A Cold War Conflict Landscape in the Borderlands of West Bohemia <i>Michal Rak, Lukáš Funk and Lenka Starková</i>	235
15	'Anzac from the Air': Re-imagining the Australian War Memorial's Gallipoli Aerial Collection <i>Luke Diggins, Kate Morschel and Snow</i>	253
16	Italian World War I Aerial Photographs for Landscape Study and Public Engagement <i>Roberta Cuttini</i>	265
17	The Aerial Perspective in a Museum Context: Above Flanders Fields 1914–1918 <i>Birger Stichelbaut and Piet Chielens</i>	279
	<i>Index</i>	293

List of Figures

1.1 Location of Comines-Warneton along the Belgian front and indication of the fields surveyed with electromagnetic induction sensor (EMI). 1: Quatre-Rois, 2: La Plus Douve, 3: Chemin des Loups, 4: Chemin du Mont de la Hutte. © authors and AGIV: orthophoto mosaic 2009

1.2 Location of military cemeteries and field hospitals in Comines-Warneton, as detected on the World War I aerial photographs. © authors and AGIV: orthophoto mosaic 2009

1.3 Time series of aerial photographs showing the evolution of Lancashire Cottage Cemetery. Red: British cemetery; green: extension; blue: present-day coverage of the cemetery with the German graves. © IWM Box Collection – Box 236 1927 42B 28U 1917 and Box 207 306 206K 28U 1918; AGIV: orthophoto mosaic 2009

1.4 Strand Military Cemetery, comparison between 11 September 1917 and 2009. © IWM Box Collection – Box 236 1929 42B 28U 1917; AGIV: orthophoto mosaic 2009

1.5 Spatial distribution of Allied and German gun emplacements in Comines-Warneton, with an indication of the density, as detected on the World War I aerial photographs. © authors

1.6 British aerial photograph (28 September 1916) of the study area with a fighting trench from 1915 (a) and

annexes (b), a series of dugouts (c), a possible communication cable (d) and an already filled-in zigzag communication trench (e). © IWM Box Collection – Box 66 37 1BT 28T 1916; AGIV: orthophoto mosaic 2009

1.7 Overview image of the study area with aerial photo-interpretation and geophysical survey. Top row: British aerial photograph and EMI survey data (ECa and MSa measurements). Middle row: interpretation of the aerial photographs and interpretation of the ECa and MSa measurements. Bottom row: combination of photo-interpretation with geophysical data, giving an indication of detected (and thus at least partially preserved) and non-detected (and thus possibly non-preserved) war features. © IWM Box Collection – Box 201 289 X3BA 28T 1918 and authors

2.1 Digital elevation model of the Geluveld Plateau and the frontlines after the First and Second Battles of Ypres. © authors and source AGIV

2.2 View of Bellewaarde Ridge. Such higher ground was difficult to overcome for the Allied troops. © O. Pauwels

2.3 Section of the communication trench, showing a clearly twisted A-frame. © F. Wyffels

2.4 Geophysical survey (P. Masters), compared to the information from several aerial photographs. © GIS data

B. Stichelbaut; geophysical survey
P. Masters

2.5 Overview of the craters at
Bellewaarde and Railway Wood.
© GIS data B. Stichelbaut; AGIV:
orthophoto source

2.6 Ullrich, a German mine, under the
British first line, exploded on
14 February 1916. © O. Pauwels

2.7 Section of an Allied frontline trench
at Bellewaarde. © F. Wyffels

2.8 Detail of the German trench,
showing remains of the wickerwork.
© F. Wyffels

2.9 German shelter, connected
to a trench. In the section traces of
sandbagging can be seen. © F. Wyffels

3.1 Location map and inset of site
showing outline of survey area. © author

3.2 Detailed map of site showing
outline of survey area in blue and the
positions of the trenches. © La Boisselle
Study Group and reproduced with their
kind permission

3.3 La Boisselle and the Glory Hole,
a British trench map dated November
1915. © author (based on WO95/2033
National Archives)

3.4 Aerial photograph of the site
showing the landscape in August
1915 with the site outlined in blue.
Reproduced by permission of the Royal
Engineers Museum, Library & Archive
4/319 C42 553

3.5 Magnetometer survey
results (top) and interpretation of
magnetometer survey results. Letters
on the interpretation relate to anomalies
discussed in text. © author

3.6 GPR profiles 13, 14 and 17.
Numbers on the interpretation relate to
anomalies discussed in text. © author

3.7 GPR horizontal time slices of
Areas 2 and 3. © author

3.8 Combined gradiometer survey
greyscale images with the aerial
photographic interpretation in red.
© author

4.1 A detail from an Aerofilms 1948
image of the former Coastguard Battery
beneath the Forth Bridge. The battery
contained two gun emplacements with
an observation post, and a magazine
and crew shelters below the battery.
SC1314756, © RCAHMS (Aerofilms
Collection). Licensor www.rcahms.gov.uk

4.2 A detail from an Aerofilms 1932
image of the loop holed wall (A)
protecting the east side of the battery.
SC1257505, © RCAHMS (Aerofilms
Collection). Licensor www.rcahms.gov.uk

4.3 The sites of the former sheds of
the Lenabo airship station, outlined in
red, are visible as clearings in dense
forestry. The three-shed arrangement is
a standard pattern. Background image
under licence, © Getmapping plc

4.4 An Aerofilms view of Gretna in
1929. Gretna was one of two towns
built to house 17,500 workers for a
vast ammunition factory. Most of the
workers' accommodation was in rows
of timber huts, a small number of which
have survived and are still occupied.
SC1256881, © RCAHMS (Aerofilms
Collection). Licensor www.rcahms.gov.uk

4.5 Map of the defences along the coast of
the Forth and Tay estuaries. © RCAHMS.
Licensor www.rcahms.gov.uk

4.6 Hedderwick Links – mapping of
defences, including trenches, barbed
wire, defendable walls and machine-gun
posts. Background image under licence,
© Getmapping plc

4.7 A small part of the Edinburgh
defences survive as slight earthworks in
Craigmillar Park Golf Course. A trench
system with a front line lies to the left of
the trees with a zigzag communication
trench extending to the right from the
sand bunker. DP175650, © RCAHMS
(Aerial Photography Collection).
Licensor www.rcahms.gov.uk

4.8 North Sutor Battery – a modern vertical aerial image with GIS layers overlain. The mapping shows that most of the camp was rebuilt for World War II, and that the gun batteries were adapted and reused. Background image under licence, © Getmapping plc

4.9 A detail of an Aerofilms image taken in 1930 recording cropmarking over an infilled section of the trench system that protected the South Sutor Battery from landward attack. SC1297997, © RCAHMS (Aerofilms Collection). Licensor www.rcahms.gov.uk

5.1 Remains of the World War I Cliffe Explosives Works by the River Thames on the Hoo Peninsula in north Kent. NMR 26866/041 28 January 2011. © English Heritage

5.2 Buried remains of World War I training trenches revealed as cropmarks near Cherry Hinton, by Cambridge. NMR 21608/15 16 April 2002. © English Heritage

5.3 Extract of English Heritage Archive 1946 RAF vertical aerial photograph showing part of Aston Down airfield (formerly Minchinhampton). RAF/3G/TUD/UK/102 VP2 5161 30 March 1946. © English Heritage (RAF Photography)

5.4 Stonehenge with the World War I aerodrome in the background. CCC 11796/4519 12 July 1928. © English Heritage (Crawford Collection)

5.5 Interpretation and mapping of archaeological features visible on aerial photographs and lidar of part of Hadrian's Wall and environs near Carlisle Airport. NMP mapping, © English Heritage. Background map, © Crown copyright and database right 2015, all rights reserved. Ordnance Survey Licence number 100024900

5.6 Extract of 1951 vertical aerial photograph showing earthworks of buildings and post holes associated with one of the World War I camps by Seaford, East Sussex. The roof of a surviving Armstrong Hut is top

centre of the frame on the edge of a former parade ground. RAF/58/613 RS 4237 5 April 1951. © English Heritage (RAF Photography)

5.7 Extract from 1942 vertical aerial photograph of the southern part of the World War I South Camp at Seaford, East Sussex. Trenches appear to overlie parts of the camp raising questions about dating. Vehicle tracks and the V-shaped arrangement of barbed wire (lower centre of photo) are World War II features. RAF/HLA/538 V 6 11 8 May 1942. © English Heritage (RAF Photography)

5.8 The Britain from Above website showing the World War I nitrate factory at Stratton St Margaret (now a suburb of Swindon) with tags added by members of the public. The project is encouraging people to look for World War I images. Image is supplied courtesy of English Heritage, RCAHMS and RCAHMS from the jointly owned Britain from Above website

6.1 Location of World War I training camps under study; Randalstown case study area marked by red box. © Crown Copyright and authors

6.2 Distribution of Sites and Monuments Records (SMRs), Listed Buildings, Scheduled Zones and location of Randalstown Camp overlain on aerial orthophotograph. © Crown Copyright and authors

6.3 Screen-capture of georeferencing procedure for Royal Engineer plan of 1915 using common points taken from modern orthophotographs and georeferenced historic nineteenth-century maps. © Crown Copyright and Royal Engineers (1915) Camp Plan - IE/MA/MPD/AS119287-002, Courtesy of www.militaryarchive.ie

6.4 Location of Randalstown Camp as evidenced on: (a) OS 6-inch map of c. 1830s, (b) Royal Engineer Plan of 1915, (c) aerial photograph (flown 2003–2006). © Crown Copyright and authors

6.5 Example of differing ALS visualisations: (a) standard hillshade, (b) local relief model (LRM), (c) Sky-View Factor. © Crown Copyright and authors

6.6 Integrating ALS topographic data, orthophotographs and the Royal Engineer plan to provide a 3D landscape view of the site of Randalstown Camp. © Crown Copyright, Royal Engineers (1915) Camp Plan - IE/MA/MPD/AS119287-002, Courtesy of www.militaryarchive.ie and authors

6.7 Analysis of the combined data has allowed for the location of: (a) the four camp entities, and (b) and (c) the key elements within each of the camps. © Crown Copyright and authors

6.8 Analysis of the ALS data reveals that there are still earthwork signatures of a range of features recorded on the Royal Engineers plan, as well as additional anomalous features. © Crown Copyright and authors

6.9 Detail of trench features as evidenced in an ALS data-derived local relief model (LRM) with georeferenced extract of Royal Engineer plan overlaid (50 per cent transparency). Source and © Crown Copyright, Royal Engineers (1915) Camp Plan - IE/MA/MPD/AS119287-002, Courtesy of www.militaryarchive.ie and authors

7.1 A georeferenced sketch map produced by the Australian Historical Mission (1919), indicating the route taken by the 11th Battalion during the Anzac landings on 25 April 1915. The points marked along the route refer to events charted by Charles Bean, author of the *Official History of Australia in the War of 1914–1918*. Source Australian War Memorial and author

7.2 The Anzac/Arıburnu area on the Gallipoli peninsula. © author

7.3 A georeferenced historic map of the Lone Pine earthworks (September 1915) overlaid on the modern landscape. The historic map shows the old Anzac frontline to the east (in black), the new

frontline established during the August Offensive (in blue) and the new Turkish frontline (in green). Dashed lines indicate subterranean works, including an extensive ‘apron’ tunnel system. Source author and Australian War Memorial

7.4 Lone Pine and 400 Plateau, part of an aerial photograph, taken on 27 October 1915, by the RNAS and restored by the Australian War Memorial. The full image can be viewed online (AWM collection number RC04275). The faint lines of tunnels can be seen running parallel to the old Anzac frontline. Source Australian War Memorial

7.5 The Lone Pine area, showing the relationship between the georeferenced map shown in Figure 7.3 and the aerial imagery captured on 27 October 1915. Source author and Australian War Memorial

7.6 Showing the results of the JHAS survey superimposed on a map produced by Brigadier General Mehmet Şevki Paşa’s cartographic team in 1916. This is part of Sheet 17 and shows the Lone Pine area. The area now occupied by the Lone Pine cemetery and memorial is also shown, providing a visual indication of the relationship between the wartime features and the commemorative landscape. The 100 m² area to the southwest of the cemetery serves as an initial test area for evaluating preservation and visibility of 1915 earthworks over time. Source author and National Archives London

7.7 A photograph taken in 1923 during the construction of the Lone Pine cemetery and memorial. Note the filling and levelling of the ground and the creation of an embankment wall. CWGC archives, Maidenhead

8.1 The Bovec basin with the location of the Koritnica gorge and the frontline during World War I shown. © Institute for the Protection of Cultural Heritage of Slovenia, Centre for Preventive Archaeology (IPCHS CPA)

8.2 Aerial view of the study area (a), multiple hillshaded DTM from ALS data of the study area (b) and identified features (c) with trenches (orange), pathways (purple), shell holes (red) and building platforms (blue). © Institute for the Protection of Cultural Heritage of Slovenia, Centre for Preventive Archaeology (IPCHS CPA)

8.3 Aerial photograph (a) and multiple hillshaded DTM of a trench incorporated in a fissure near Kraljišče (b). Note the patches of snow in depressions, dwarf pine (*Krummholz*) patches and the low quality of the DTM. © Institute for the Protection of Cultural Heritage of Slovenia, Centre for Preventive Archaeology (IPCHS CPA)

8.4 3D view of the Koritnica gorge from ALS data (a) and features identified (b). © Institute for the Protection of Cultural Heritage of Slovenia, Centre for Preventive Archaeology (IPCHS CPA)

8.5 Rombon battlefield with trenches (orange), pathways (purple), shell holes (red) and building platforms (blue). © Institute for the Protection of Cultural Heritage of Slovenia, Centre for Preventive Archaeology (IPCHS CPA)

8.6 Trenches on Totenkuppe 1 integrated in the topography. © Institute for the Protection of Cultural Heritage of Slovenia, Centre for Preventive Archaeology (IPCHS CPA)

8.7 3D view of Kote 1313 from ALS data. © Institute for the Protection of Cultural Heritage of Slovenia, Centre for Preventive Archaeology (IPCHS CPA)

8.8 Building sheltered by a cliff (a), caverns hewn into the rock (b) and trench parapets constructed as dry stone walls (c). © Uroš Košir

9.1 Map of the Eastern European 'Gas-scape'. The red line represents the Russian, the blue, the German frontlines, while the tri-colour stripes represent gas attacks. Source private collection of A. Zalewska and J. Czarnecki

9.2 ALS data visualisation of the area (indicated by a dotted line) which deserves the greatest attention and both cognitive and social care, and which, after the first season of research was recommended by archaeologists in December 2014 as the potential area of a 'Monument of History' (oryg. 'Pomnik Historii' – one of the highest forms of protection in Poland). Source raw data from GUGiK resources – licence No. DIO.DDZ.7211.15877.2014_PL_N; A. Zalewska: concept and G. Kiarszys: visualisation. © Project APP

9.3 The unique evidence of the presence of a 'Gas Regiment' in Rawka: the monument dedicated to the Pionier-Regiment Nr. 36, which used to be situated next to the Church of St Anna in Bolimów. Photography from the resources of the Archive of the Polish Army Museum, reproduced courtesy of its Principal, Z. Wawer

9.4 A war landscape of ruined villages and destroyed fields and forests were left as silent witnesses of the events of 1915, pictured here close to Bolimowska Wieś. Source private collection of A. Zalewska and J. Czarnecki

9.5 The trees had been shot through so many times that they collapsed to the ground and lay there. Photograph of ruined forest close to Rawka River. Source private collection of A. Zalewska and J. Czarnecki

9.6 The interpretative challenge: a photograph signed: '*gr mas ros w m Mogiły Skierniewice*' (author and date unknown), found in the Archive of the Polish Army Museum, reproduced courtesy of its Principal, Z. Wawer

9.7 Visualisation of Joachimów-Mogiły War Cemetery from ISOK (Informacyjny System Ochrony Kraju – Information System for the Protection of the Country), part of the publically accessible lidar product, which is available not only to archaeologists but also to militaria hunters/detectorists

9.8 The advanced ALS visualisation of Joachimów-Mogiły War Cemetery, with marked objects interpreted as the resting places of Polish, German and Russian soldiers from World War I.

Source A. Zalewska: concept and G. Karszys: visualisation. © Project APP

9.9 Entrance to the War Cemetery showing the inscription which reads (in German and in Polish): 'GERMAN WAR CEMETERY JOACHIMÓW MOGIŁY 1939–1945'. Source author

9.10 The Eastern European Gas-scape near the Joachimów-Mogiły Cemetery, close to former no-man's land, with a robbery pit in the foreground (2012). Source author

10.1 Aerial photographs of downtown Darwin in 1944. Source National Library of Australia, Aerial Photograph Collection D 52 4 32

10.2 A new government-funded interpretation panel near Darwin (left) and an older private heritage initiative (right) in Adelaide River. © G. Plets

10.3 Map of Australia marked with key sites referred to in the text. © authors

10.4 Example of a flight diagram. Source National Library of Australia, Aerial Photograph Collection D 52 8 54, Flight diagram 'Adelaide River 1942'

10.5 Australian aerial photograph depicting the area immediately north of Adelaide River Township in 1942. Source National Library of Australia, Aerial Photograph Collection D 52 8 54, flight no. 256/1, photo VX220

10.6 Typical surface remains, artefact scatter and concrete slab foundations near Adelaide River. The location of this site is indicated at Figure 10.10 D. © B. Stichelbaut

10.7 Comparison of the 1936 and 1949 orthophotos illustrating the rapid landscape change. Source National Library of Australia, Aerial Photograph Collection D 52 8 54. Top: flight no. Eagle 68,

photo 9,975. Bottom: flight no. 8.754, photo 15

10.8 Snake Creek Explosives Storage Depot in 1949. Source National Library of Australia, Aerial Photograph Collection D 52 8 54, flight no 8.754/42, photo 21

10.9 Remains of an ammunition bunker at Snake Creek Explosive Storage Depot in December 2014. © B. Stichelbaut

10.10 GIS mapping of the conflict landscape. A: Snake Creek ammunition storage area, B: 119 Australian General Hospital, C: hospital train railway sidings, D: military camp with extensive material remains, E: Army farms, F: High-Frequency Direction Finding Antenna base. © authors

11.1 Map of northwest France showing locations of case study sites © authors

11.2 A) Aerial reconnaissance photograph of Cagny (IWM CL477) taken on the morning of 18 July 1944 following bombing in support of Operation Goodwood; B) Aerial photograph of Cagny taken on 12 October 1945 (IGNF C1612-0091_1945_CDP216_0747) showing cratering associated with bombs fused with a 0.25 second delay. Note lack of evidence for cratering associated with bombs with instantaneous fuses (see text for details). Inset frames show location of Figures 11.3A and 11.3B

11.3 Aerial photographs of infilled bomb craters in fields at Cagny taken on 12 October 1946 (see Figure 11.2 for location): A) IGNF C1612-0291_1946_CDP2202_4120; B) IGNF C1612-0291_1946_CDP2202_4124 © authors

11.4 Aerial photograph dated 25 July 1947 (IGNF C1213-0071_1947_F1213-1313_0023) of La Chapelle-en-Juger (lower frame), near Saint-Lô, showing extant and infilled bomb craters associated with Operation Cobra

11.5 Aerial photographs of V-weapons facility in Bois Carré, near Yvrench,

Picardy: A) Reconnaissance picture dated 28 June 1944 (IWM: HU 92984) showing bomb craters of raids between 31 December 1943 and 19 June 1944; B) IGNF C2207-0031_1947_F2207-2307_0165); C) IGN image dated 29 April 1952 (IGNF C2007-0061_1952_F2007-2307_0062)

11.6 Aerial photographs of ex-Luftwaffe airfield at Conches-en-Ouche, Haute-Normandie: A) IGN image dated 1 July 1947 (IGNF C1914-0011_1947_F1914-2115_0054); B) IGN image dated 7 March 1960 (IGNF C1914-0041_1960_F1914-2214_0011). Inset frame shows location of airfield ammunition depot (Figure 11.10). Locality X (11.6A) marks ordnance disposal activities

11.7 Aerial photograph dated 9 August 1947 (IGNF C1411-0051_1947_F1411-1612_0057) showing site of former Allied Advanced Landing Ground A-19 at Lavielle (St-Georges-d'Elle), near Saint-Lô. Inset: Photograph of the present site of the airfield, taken from location X looking south along the former runway

11.8 Aerial photograph dated 14 April 1949 (IGNF C1816-0011_1949_F1816-2116_0014) and interpretation of Luftwaffe ammunition depots at Maintenon. Locality X marks off-site ordnance disposal area

11.9 Aerial photograph dated 23 April 1946 (IGNF C1516-0081_1946_CDP2017_0186) of the Route Forestière de l'Épinette (D387), Forêt domaniale des Andaines, near Bagnoles de l'Orne showing ordnance disposal activities. Detonation craters most probably correspond to sites of former munitions bunkers (see text for details)

11.10 Aerial photograph dated 12 April 1948 (IGNF C1914-0061_1948_CDP3013_0035) of ammunition (bomb) depot on western margin of Luftwaffe airfield at Conches-en-Ouche, Haute-Normandie (see Figure 11.6 for context). Note focus of clearance and disposal activity in southern part of the depot

12.1 Cover plot of selected MAPRW imagery held by AFN for Emilia Romagna. Red outlines show coverage from 1943, orange from 1944 and green selected coverage from 1945. By permission of the Istituto Centrale per il Catalogo e la Documentazione – MiBACT

12.2 Top: Monthly bomb tonnage dropped on Italy and Sicily 1940–45; bottom: the overall distribution of bomb tonnages (Bombing Survey 1947)

12.3 Provincia di Alessandria Project: known number of bomb craters. Source author

12.4 Bomb craters mapped on the *Carta Tecnica Regionale*, with the inset showing an extract of the source imagery (ICCD, AFN. MAPRW 5CM/1145ADB, 4029, 03/09/1944). By permission of the Istituto Centrale per il Catalogo e la Documentazione – MiBACT

12.5 ICCD, AFN. MAPRW photo of Udine, 16 April 1945, with inset showing bomb craters mapped on the *Carta Tecnica Regionale* (Fornaciari 2013)

12.6 Ala Trento. Bomb craters mapped from World War II aerial photographs displayed against a 1993 image showing the extensive urbanisation of this area (Finotti and Tonelli 1997)

13.1 Location of sites/landscapes discussed in the text. © G. Kiarszys

13.2 Historical city centre of Głogów in 1959. © CODGiK

13.3 German aerial intelligence photograph of Głogów taken on 16 March 1945. © NCAP / ncap.org.uk

13.4 Contemporary aerial photograph of the historical centre of Głogów. © W. Rączkowski

13.5 Historical city centre of Stargard in 1938. © NCAP / ncap.org.uk

13.6 City centre of Stargard in 1977. © CODGiK

- 13.7 Aerial photograph of Miedzianka taken on 27 September 1975. © CODGiK
- 13.8 The remains of Miedzianka. ALS SVF visualisation. © G. Kiarszys
- 13.9 Field divisions and ruined farms in the vicinity of Miedzianka. ALS SVF visualisation. © G. Kiarszys
- 13.10 The village of Ostrawa photographed on 23 July 1974. © CODGiK
- 13.11 The remains of the grange and manor house at Ostrawa. Combined Local Relief Model and Digital Terrain Model derived from ALS data. © G. Kiarszys
- 14.1 The landscape as a reference of the Cold War. An example of the Iron Curtain in western Bohemia in 1982. The picture shows the fences, transmitting tower and a precast concrete bunker marked with a black cross. © State District Archive Tachov
- 14.2 Border Guard barracks in the village of Stara Knizeci Hut photographed in 1985. The members of this crew guarded the area between the deserted villages of Jedlina and Hraničky. Note the fences of the Iron Curtain, running around the barracks. © State District Archive Tachov
- 14.3 Photogrammetrically documented pillbox. Single-image photogrammetry was processed through 123D Catch. © J. Čibera, L. Starkova
- 14.4 Terrain model from ALS visualised using the Sky-View factor algorithm. Remains of the defensive line, running north-south can be seen in the centre of the image. © J. Čibera, L. Starkova
- 14.5 Comparison of visibility and a detailed view of each object of the field fortification line based on ALS combined field mapping using a Leica TS1200 total station. © J. Čibera, L. Starkova
- 14.6 Shelter for a heavy military vehicle. © L. Funk
- 14.7 Electrical insulators of several types near a rotting pole from the Iron Curtain fence. © L. Funk
- 14.8 The fence lines are not clearly visible in the pasture northwest of Jedlina and the reconstruction is based on ALS data. The former presence of the village is preserved today only as a cemetery, which is visible in the centre of the image. © L. Funk
- 14.9 North of the deserted village of Jedlina fences enter the forest. At the edge of the forest their presence is still visible due to the naturally seeding vegetation. © L. Funk
- 14.10 The landscape of the 'Cold War' between the deserted villages Jedlina and Hraničky. The plan shows three courses of 'wires', areas with the largest concentration of archaeological artefacts and the object placement of permanent field and defensive systems © J. Čibera, L. Starkova
- 15.1 A Henri Farman F.27 floatplane of the RNAS at a launching ramp after completing a patrol over the Gallipoli peninsula. Source AWM P03309.002
- 15.2 Staff of the War Diaries Subsection transcribing records at the London headquarters of the Australian War Records Section. Source AWM D00627
- 15.3 A view of the newly redeveloped World War I galleries showing the entrance and Ascot Boat, an iconic relic from the Anzac landing. Source AWM PAIU2014/252.16
- 15.4 The combined aerial mosaic stitched together by the Memorial's Multimedia section during concept testing. Source AWM P11489.001
- 15.5 Staff demonstrating points of interest and information boxes in 'Anzac from the Air'. Designed and developed at Holly, Sydney. Includes material © CNES 2014, Distribution Astrium Services / SPOT image S.A., France. Source AWM PAIU2015/003.001

15.6 A detailed view of 'Anzac from the Air' showing the primary navigation interface. Designed and developed at Holly, Sydney. Includes material © CNES 2014, Distribution Astrium Services / SPOT image S.A., France. Source Lucy Parakhina, 2014

16.1 Aerial view of the city of Udine. Courtesy Fototeca Vigna di Valle

16.2 Trench lines on the Fajti – Karst. Comparison of map and photo. Source author

16.3 Hay barn camouflage of a gun emplacement. Courtesy ISCAG

16.4 Camouflaged road. Courtesy ISCAG

16.5 Grado, comparison of World War I aerial photograph and contemporary orthophoto. Source author and courtesy LP and the Autonomous Region of Friuli Venezia Giulia

16.6 A flight simulator frame of the Alisto project. On the left the World War I landscape with some old annotations in red, on the right the present landscape. The menu on the left side enables activation of thematic guided tours and the highlighting of military targets. The control column below allows touch-screen surfing or activation of the joystick, choice of language and visualisation mode on the screen. Courtesy LP Alisto Project

16.7 Flight simulation over the city of Treviso during the war (right) and today (left) with identification dots on the present landscape. The area not covered by the historical photos is depicted through IGM maps. Courtesy LP Alisto Project

16.8 Simulated airborne Austro-Hungarian Lohner (a reconnaissance flying boat produced in Austria-Hungary during World War I). Courtesy LP Alisto Project

16.9 Educational game about the organisation of airfields. Courtesy LP Alisto Project

17.1 Historical aerial photograph on top of a modern day orthophoto. Courtesy of the In Flanders Fields Museum and Orthophoto © Agentschap Geografische Informatie Vlaanderen

17.2 German oblique aerial photograph (31 October 1917) of the centre of Passchendaele during the Third Battle of Ypres. Only some walls of the church are still standing, the remaining parts of the village are almost invisible as they were pulverised by artillery fire. Less than two weeks later the village was captured and the offensive put to a halt. Courtesy of the In Flanders Fields Museum

17.3 In Flanders Earth installation in the IFFM. Each pillar of the construction contains a large multi-touch tablet. Courtesy of the In Flanders Fields Museum. © authors

17.4 Overview of historical aerial photographs included in the application and hotspots © authors

17.5 Interface of In Flanders Earth. With (a) inset map, (b) address search engine, (c) historical aerial photograph, (d) historical ground photograph, (e) site, (f) 'hotspot', (g) transparency slider and (h) previews of historical aerial photographs within the extent of the screen. Courtesy of the In Flanders Fields Museum



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Series Introduction: Material Culture and Modern Conflict

Modern warfare is a unique cultural phenomenon. While many conflicts in history have produced dramatic shifts in human behaviour, the industrialised nature of modern war possesses a material and psychological intensity that embodies the extremes of our behaviours, from the total economic mobilisation of a nation state to the unbearable pain of individual loss. Fundamentally, war is the transformation of matter through the agency of destruction, and the character of modern technological warfare is such that it simultaneously creates and destroys more than any previous kind of conflict.

The material culture of modern wars can be small (a bullet, machine-gun or gas mask), intermediate (a tank, aeroplane, or war memorial), and large (a battleship, a museum, or an entire contested landscape). All share one defining feature – they are artefacts, the product of human activity rather than natural processes. In this sense, for example, World War I's Western Front is as much a cultural artefact as a World War II V2 rocket, a Cold War early-warning radar station, wartime factories and bombed buildings, as are photographs, diaries, films, war souvenirs, and a host of conflict-related art forms. Similarly artefactual, though not always understood as such, are people – the war-maimed (sometimes fitted with prostheses), war refugees and their camps, collectors of memorabilia, and the post-conflict 'presence of absence' in towns and cities of large numbers of missing men, women and children. Each in their own way – through objects, memories, attitudes and actions – perpetuate different engagements with conflict and its painful and enduring aftermath.

The material culture of conflict offers a field of study which is both rich and fiercely relevant to the world which we inhabit. Wars and other forms of conflict have formed that world. Today we still live in the shadow of two world wars which set new standards for extremes of violence, and violent conflicts remain in progress across the globe as this series of books is inaugurated. These events have created a truly massive volume of material culture. The ways in which people engage with it is conditioned by society's equivocal attitude to violent conflict itself. As John Keegan wrote, 'We are cultural animals and it is the richness of our culture which allows us to accept

our undoubted potentiality for violence but to believe nevertheless that its expression is a cultural aberration' (Keegan, *A History of Warfare* 1994). Keegan himself knew that the reality was not so clear cut as this reassuring vision. The relationships which people have with the material culture created in a context of violence add weight to this assessment, for they are simultaneously capable of supporting or undermining the perception of warfare as an aberration or exception.

Now as never before, we perceive unfamiliar but underlying truths in the way in which these artefacts reveal infinitely varied interactions with people: a 'social life' created by human engagement with objects. Although overwhelmingly inanimate, they are not merely passive signifiers, reifications or receptors of 'meaning', but can exercise positive agency in forming and embodying human thoughts and emotions. In short, objects make people as much as people make objects. The behaviours provoked by conflict illustrate how an individual's social being is determined by their relationship to the objects that represent them – how objects are a way of knowing oneself through things both present and absent. This is as true for World War I battlefield pilgrims (often widows), survivors of the Holocaust, and World War II civilian internees and prisoners of war, as it is for uniformed service personnel who took part in both world wars, the Vietnam War, the Sarajevo militia of the Bosnian Conflict, and the war-maimed from Afghanistan and Iraq to name just a few.

A further incentive to focus on this subject lies in developments in the academic world. For decades, anthropologists and historians have devoted increasing amounts of effort to the study of conflict. Until recently their studies have followed discrete paths, but change has been afoot since the closing years of the last century. A slow-burning revolution in academic engagement with warfare (not to say a 'rebranding') relocated historians of conflict from the unfashionable suburb of 'military history' to uptown locales like 'war studies' and 'First World War studies'. Everyone now accepts that what we call 'peace' cannot be understood without knowing what happens in wars, any more than wars can be comprehended in isolation. Furthermore, ground-breaking work began to appear in which historians addressed wars from the perspective of their material and cultural milieus or manifestations.

Parallel advances have been occurring in the disciplines of archaeology and anthropology. The re-appraisal of materiality has been at the forefront of these developments. The ways in which we view and think about the things we make, their complex volatility, and their elusive meanings have been brought under academic scrutiny. The transformative quality of the material culture of modern conflict, and its ability to move across disciplinary boundaries, demands a robust interdisciplinary response. Focused on material culture, such an approach offers to revitalise investigations into the physical and symbolic worlds that conflict creates, and that defines us as subjects through memory, imagination, and technology.

Since the turn of the millennium the editors of this series have taken a lead in focusing the gaze of both disciplines on the material culture of conflict.

Moreover, they have opened the discussion out to practitioners of the widest possible range of disciplines and vocations, including historians, anthropologists, archaeologists, museum curators and artists. For this growing international group of collaborators, the material culture of conflict represents the nodal point at which their disciplines can meet and cross over. This series of books seeks to build on this foundation and to offer a platform for those wishing to publish new research on the subject.

The series adopts a genuinely interdisciplinary approach to re-appraise the material legacy of twentieth- and twenty-first-century conflict around the world. By conceiving and studying the material culture of conflict, it helps to construct biographies of objects, and explore their 'social lives' through the changing values and attitudes attached to them over time. The series aims to show how objects can survive as expressions of 'war beyond conflict', revitalising meanings, and creating new engagements between and understandings of people and 'war things'. It offers new perspectives on the intricate web of connections that bind and separate people and places in times of conflict and beyond.

In so doing, the series offers a radical departure in the study of modern conflict – proving a truly interdisciplinary forum that draws upon, but does not privilege archaeology, anthropology, military and cultural history, art history, cultural geography and museum and heritage studies. The complexity of modern conflict demands a coherent, integrated, and sensitised hybrid approach which calls on different disciplines where they overlap in a shared common terrain – that of the materiality of conflict and its aftermath. This approach has extraordinary potential to bring together the diverse interests and expertise of a host of disciplines to create a new intellectual engagement with the understanding of conflict.

Nicholas J. Saunders, University of Bristol
Paul Cornish, Imperial War Museum, London
September 2015



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Series Editors' Preface

Nicholas J. Saunders and Paul Cornish

The aerial perspective has taken a grip on the way in which we imagine the world. Not so long ago, in the pre-Internet era, this way of seeing was largely the preserve of a select coterie who enjoyed access to the results of military reconnaissance or espionage. Everyone else was limited to squinting through the inadequate windows of airliners, or vicariously enjoying the wonderment of artists who had got airborne – such as the Carline brothers or C.R.W. Nevinson, or even of those who had not but imagined it, like Paul Nash. Now we are able to navigate our way through satellite images of the globe on our computers or smartphones. Furthermore, archives and museums are making available, often online, aerial images taken for military or governmental purposes. This second form of imagery has a direct connection with the history of conflict – and particularly war in Europe. The European war fronts of the two world wars were subjected to dense and comprehensive surveys from above, as the war-driven technology of aerial photography was applied to static or semi-static frontlines, or even used to probe deeper into enemy territory, now no longer hidden on the ‘other side of the hill’.

It is not difficult to imagine how resources like these might grasp the imagination of those engaged in the study of conflict – whether they work in the realms of archaeology, history, anthropology, heritage or museums. Even as an easily searchable ‘map’ to accompany a straightforward work of military history, Google Earth is a godsend. The ability to ‘fly’ around in the topography offers still more, as both of us have discovered in our respective research. On first downloading it, Paul set about mapping the opposing fortresses which faced each other across the precipitous borders of Italy and Austria-Hungary in the Trentino in 1915, then traced Erwin Rommel’s 1917 route up Matajur in the Soča/Isonzo Valley. More recently it revolutionised his understanding of the 1944 Battle of Normandy, where the possession of dominant topographical features was the key to victory. Similarly, Nick’s research in southern Jordan, investigating the archaeology of the Arab Revolt (1916–18), has been greatly enhanced by the ability to identify from above the

full extent of hitherto unknown conflict landscapes flanking the Hejaz Railway whose presence was first detected by extensive fieldwork. Combining satellite imagery, historical and modern aerial photographs, geophysical prospection and archaeological intervention produced a uniquely holistic view of a previously un-investigated and unexpectedly rich war landscape.

Aerial reconnaissance photographs obviously invite different forms of interaction from the viewer. They offer not only a snapshot of a piece of terrain at a single moment in time, but an insight into landscapes now irrevocably altered. Combined with satellite imagery, they provide the student of warfare with an *aperçu* of the subject which is totally different from perceptions gathered through the more traditional media of maps, guidebooks, battlefield tours or museums. In fact, general access to the aerial perspective might be said to have created a completely new mental map of the wars of the twentieth century.

The advantages of exploiting such a rich resource in archaeology are perhaps self-evident, although the papers in this volume will surprise in the breadth and variety of the ways in which this is achieved. The concept of a 'palimpsest' is commonly used to describe archaeological sites. It is also peculiarly applicable in the context of aerial imagery; and in more than one sense. At the most prosaic level one might envisage the aerial image as the top layer, giving indications of hidden artefacts and structures which archaeologists might investigate further, by geophysical survey or by excavation. But the images themselves may have palimpsestic characteristics, and be capable of revealing multiple layers of evidence. This is because such images are also material culture, and how we understand them is influenced not just by pixels and analytical procedures, but by politics, history, ideology and sometimes wishful thinking.

Wartime reconnaissance photographs may record traces of ancient agriculture and industry, revealing evidence now obscured by forestation or urban growth. They may also expose a palimpsest of different wars. One example, described in this book, shows a fortress built on fifteenth-century foundations, captured in 1509 by the army of the Holy Roman Emperor Maximilian I but proving, in 1915 – due to topography – immune to the howitzer shells of the Italian army bent on seizing it from his descendant, the Emperor Franz Josef ([Chapter 8](#)).

Post-war aerial photos record the gradual overlaying of peacetime redevelopment and recovery ([Chapter 11](#)) or even, conversely, post-war destruction ([Chapters 13 and 14](#)) – a manifestation of 'cold' rather than 'hot' war. Others document the creation of a memorial landscape cutting across the archaeology of the conflict it commemorates ([Chapter 7](#)). On a different level, looking beneath the 'top layer' provided by aerial images reveals a contested archaeology in which shifting ethnic and political conflicts have influenced the way in which sites are preserved or investigated ([Chapters 6 and 9](#)).

Above all perhaps, the application of an aerial perspective, using the abundance of evidence at our disposal, gives us the ability to comprehend the

enormous reach and incredible variation of the lands over which the European wars of the twentieth century were fought. They can also teach archaeologist and historian alike the dominant role which terrain and topography played in the fighting. As a German eye-witness states in [Chapter 9](#) 'Landscape is a force' and it is the interaction between the force of landscape and the force of war which archaeology founded on aerial imagery so eloquently reveals.



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Introduction:

Conflict Landscapes and Archaeology from Above

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Background

Modern conflict archaeology is a relatively new field of practice, but one that has rapidly demonstrated the value of archaeological perspectives in offering unique sources of knowledge and insights that enrich our understanding of the materiality of war. The rapid developments in conflict archaeology as an area of specialist practice are a reflection of the synergies between different perspectives and backgrounds, drawing on archaeological methods and thinking, and including historians, geographers and museum curators, to name a few (Saunders 2002, 2012). This volume reflects that mix of disciplines, but focuses on the contribution of an airborne and remote sensing perspective set within a broad framework that includes geophysical survey, documentary and historical sources, bodily engagement, and dissemination and public engagement. With this focus the volume draws on the well-established sources of the aerial photographic record and geophysical survey, and includes contributions that demonstrate the power of high resolution topographic data from Airborne Laser Scanning (ALS). These are among the building blocks for strong landscape-based narratives that explore place and process from many perspectives, illustrating the richness of the integrated perspective on conflict landscapes that is at the heart of this volume.

Modern Conflict Archaeology

Since the late twentieth century the study of the archaeology of World War I (Saunders 2002, Desfossés 1998), World War II (Bulgrin 2006, Gaffney et al. 2004) and more recent conflicts (Schofield and Cocroft 2007) has come to be accepted as a legitimate professional and academic field of research. It has rapidly expanded over the last decade, with a major shift from traditional

battlefield archaeology, with a focus on actual battlefields, towards stimulating cross-disciplinary approaches that seek understandings of past and past-in-present landscapes, the materiality of conflict, and the commemoration of conflict in the (recent) past. In this development, new linkages are being drawn between aerial photographic interpretation, archaeological prospection and excavation, historical and anthropological research, and sociological and museum studies.

Modern Conflict Archaeology from Above

With its emphasis on the airborne and landscape perspective this volume draws together two potent viewpoints for the study of twentieth-century conflict landscapes, their surviving archaeological remains and their (re-)interpretations in historical narratives and for public engagement. On the one hand, historical aerial photographs which are contemporary with the time period studied provide unique and rich views of past landscapes that often record the processes that formed them. The value of historical aerial photographs is increasingly widely appreciated (Cowley and Stichelbaut 2012) for the uniquely textured views of the past they provide, and, because many of them were taken as a result of military operations, they provide a powerful contemporary view of conflict. Moreover, aerial photographs, whether historic or contemporary, encourage a holistic perspective of landscapes. The rapid development in aerial photographic techniques during World War I has had a lasting legacy, not only in military intelligence of course, but quite fundamentally to the development of archaeology, while for modern conflict archaeology it has meant that all subsequent conflicts can be explored from a contemporary aerial perspective, using the past (contemporary) landscape as a secure starting point for analysis.

On the other hand, a complementary perspective lies with approaches that use the present-day landscape palimpsest as a starting point. Here, prospection tools such as ALS and geophysical survey characterise the contemporary landscape and support interpretations from a present-day perspective, also recognising the interest in the development of landscapes after conflict and the different expressions of that past in the present. These are not alternative approaches, but rather different starting points for landscape analysis that is at its most powerful when drawing on an integrated and complementary suite of sources. Such a landscape perspective looks both to broader spatial patterns in the contemporary setting, and also to the *longue durée*.

This is part of a broader trend in landscape archaeology that is being further stimulated by the increasing availability of high-resolution ALS data (for example Opitz and Cowley 2013) and recent technical advances in geophysical prospection techniques (Gaffney et al. 2012). These developments mean that large-area, detailed prospection across many hectares and kilometres of landscape is a reality that was previously the preserve of a 'site'-orientated approach.

However, such technological advances should never be an end in themselves, as they allow documentation, but require problem-orientated frameworks to move beyond basic site discovery and identification to interpretations of past landscapes. Moreover, uses of these new tools must be underpinned by the broader-based knowledge and experience of landscape interpretation, whether that is in examining aerial imagery, working with an ALS-derived visualisation or examining topography in the field.

However, while such developments in remote sensing prospection techniques are important, this is not to advocate a 'remote', disengaged approach to the archaeologies of modern conflict. Indeed, bodily engagement with the material remains and landscape features is equally important, whether this is by the researcher or visitor in the landscape, or through the efforts to convey space and place to museum visitors whose direct physical engagement with the landscape context may be limited. This perspective foregrounds the visceral nature of conflict and moves beyond the landscape as an arena for historical events, to explorations of the physicality and reality of the day-to-day from a human perspective. Moreover, as the legacies of conflict remain a highly potent force in many societies today, and live on beyond the lifetimes and direct memories of combatants and civilian populations, the continuing psychological, social and political impacts are a manifestation of the entanglement of intangible cultural heritage with the materiality of conflict. Such a multi-faceted perspective draws on the remote sensed data, and recognises the importance of bodily engagement and the profound enduring physiological and social impacts of conflict, to develop rich narratives. Many of these narratives are strongly connected to the present, whether in the continuing threat to contemporary populations from unexploded ordnance or in the enduring impact of the Iron Curtain on settlement patterns and human populations.

Memory, Public Engagement and 'Landscape as Last Witness'

Remembrance is a powerful central theme in societal and personal strategies for managing the legacy of conflict – in acknowledging sacrifice, in hoping to learn from the past for the future, and in passing memory and knowledge to future generations. This is especially marked as this volume is being compiled during the centenary of World War I, a conflict that now has no living witnesses. While certain aspects of remembrance are enshrined in established practices such as Armistice Day and the Holocaust Memorial Day, or in formal structures such as war memorials and military cemeteries, public engagement through museums and other avenues is a different arena for the transmission of history and memory that demands effective communication. Here, the use of the aerial perspective has not been developed as widely as might be expected, though aerial imagery is routinely used for illustrative purposes. This may be partly because of a perception of the aerial view as remote,

disembodied and impersonal. However, there is growing recognition of the potential of an aerial perspective in innovative museum and educational contexts, bringing the landscape-based approach of conflict archaeology to bear in public engagement. In these contexts the aerial imagery is developed beyond a merely illustrative role, to providing rich sources of information and a basis for interaction with the landscape past and present, and exploration of places, events and processes.

While aspects of these developments inevitably occur within the physical confines of a museum building and attempt to bring the landscape into the museum, they increasingly offer the opportunity through smart mobile devices to take the museum into the landscape. This is a development of the concept of the 'landscape as last witness' within the In Flanders Field Museum, Ypres, through the 'In Flanders Earth' application (see also [Chapter 17](#)) that facilitates a wide range of interactions through an innovative touch-screen facility in the museum building that draws heavily on contemporary and historic aerial images. The ability to confront past and present, and use this to explore a landscape adds a major new dimension to public appreciation of World War I in this region. However, this perspective is being further developed to support that interaction in the surrounding Flanders landscape, allowing visitors to explore a heavily altered landscape with reference to World War I photographs that show the war-torn fields, farms, villages and towns. This is an exciting development, bringing a landscape-based approach to conflict archaeology to facilitate embodied interaction with places and spaces across a 100-year period. Our surroundings are complex palimpsests of processes and reservoirs of information, and in this context the concept of 'last witness' has a more general applicability in conveying why a landscape-orientated approach matters.

The Origins and Structure of this Volume

The origins of this volume lie in the ArchaeoLandscapes Europe project (<http://www.arland.eu/>), which has been funded by the European Union over the period 2010 to 2015 to encourage the uses of modern surveying and remote sensing techniques for archaeology throughout Europe. Within this framework a specific objective has been to increase access to and use of archives of historical aerial photographs for archaeology and landscape studies in general, in the knowledge that they may be unique sources of information for landscapes that have changed enormously during the twentieth century. Recognising the importance of such imagery, the aerial perspective and other remote sensing data to conflict archaeology, an international conference entitled 'Conflict Landscapes from Above' was held at the In Flanders Fields Museum in Ypres in May 2014. The conference brought together researchers from a range of disciplines studying conflict landscapes over a wide geographic range and time period, including, but not limited to the two World Wars.

This volume draws on selected conference presentations and additional commissioned papers to present examples of the state of the art in the use of modern prospection techniques integrated with complementary sources and perspectives to investigate twentieth-century conflict within a landscape context. It builds on work presented in *Images of Conflict* (Stichelbaut et al. 2009), which was the first volume to focus on conflict archaeology from an aerial perspective, illustrating the huge potential of military aerial photographic archives (Beylot 2009, Castrianni and Ceraudo 2009, Going 2009, Haupt 2009) and their utility for historical documentation and analysis. Similar themes have been touched on in subsequent publications, mainly in highlighting the general importance of historical aerial photograph archives for archaeological and landscape studies, but also presenting further examples of the use of such archives and sources for the study of twentieth-century conflicts (Cowley et al. 2010, Hanson and Oltean 2013).

This volume is a significant development from these earlier volumes. Not only does the field of modern conflict archaeology continue to develop, but archaeological prospection techniques such as ALS have rapidly emerged to provide perspectives that were undreamed of a decade ago. Thus, by bringing together traditional approaches that draw on historical and contemporary aerial photographs with cutting-edge techniques such as ALS and advanced geophysical prospection, this volume draws together papers on conflict landscapes across the globe throughout the twentieth century from a range of disciplines, including archaeology, history, geography, and heritage and museum studies. These all illustrate the utility of integrated aerial and landscape perspectives to provide unique insights on conflicts and their legacy, and the complex issues for heritage management. Some of the general cross-cutting themes of the volume are outlined above, which is otherwise organised in a broadly chronological framework.

World War I saw an unprecedented global conflict across many theatres of war, each with its own distinct landscape settings and individual challenges to methodology and understanding. Chapters investigate the Western Front in Belgium (Chapters 1 and 2) and France (Chapter 3), where the industrial scale of World War I is reflected in the extensive preserved material remains both above and beneath the surface. The former Western Front can perhaps be described as one of the largest archaeological sites in the world and the sheer quantity of the features creates management challenges. The combination of historical aerial photographs, ALS data and geophysical survey enables, more than ever before, integrated research across large areas of conflict landscape. Since the development of ‘modern conflict archaeology’ (see, for example, Saunders 2012) there has been a growing realisation that the archaeology and heritage of this conflict goes beyond the battlefields, and this is clearly illustrated in chapters highlighting the global reach of the conflict in case studies from Scotland (Chapter 4), England (Chapter 5) and Ireland (Chapter 6) which inform our understanding of ‘the Home Front’.

While the Western Front in Belgium and France is often a focus of attention, the global reach of World War I is shown in discussions of Gallipoli (Chapter 7),

the often overlooked Alpine Front in Slovenia ([Chapter 8](#)), the Eastern Front in Poland ([Chapter 9](#)) and, in the context of public engagement, Italy ([Chapter 16](#)). This geographic range of papers related to World War I highlights the global scale of the conflict and the challenges to develop effective methodologies and approaches that support exploration of the diverse landscapes and socio-political contexts and the different contemporary impacts.

For World War II and any other conflict since, the availability of historical aerial photographs and satellite imagery increases significantly, and global aerial photographic collections (for example in the UK and USA) and national collections (for example in Italy) hold many millions of aerial photographs taken to inform military intelligence and planning (for example Cowley and Stichelbaut 2012, Cowley et al. 2013). These are used to good effect in case studies that deal with World War II in Australia ([Chapter 10](#)), Normandy ([Chapter 11](#)) and Italy ([Chapter 12](#)) in which the enduring presence of the remnants of conflict is a recurrent theme. This ‘past-in-present’ landscapes theme is further presented in more recent contexts through discussions of post-World War II conflicts and their legacies in Western Poland ([Chapter 13](#)) and West Bohemia ([Chapter 14](#)) during the Cold War era.

Beyond the academic and heritage management contexts, the aerial perspective on conflict archaeology offers new ways of representing past landscapes to a wide audience. The combination of modern technology and historical imagery can be used to give aerial photographs a new meaning, no longer sources of military intelligence examined by photo-interpreters, but sources to provide audiences with a different perspective that shows how war was influenced by the landscape and how war changed the landscape. Three papers in this volume highlight new museum installations or other public engagement initiatives, all of them with the same objectives in common: to bring the landscape into the museum and/or to a wider public and to encourage interaction with, and comparison of, past and present landscapes.

The ‘Anzac from the Air’ display in the Australian War Memorial uses a large touch-screen of aerial reconnaissance photographs from 1915 to encourage exploration of the campaign ([Chapter 15](#)), while the implications of extensive research on the World War I Italian Front for public engagement through digital media are discussed in [Chapter 16](#). The volume concludes with a presentation of the ‘In Flanders Earth Application’ in the In Flanders Fields Museum in Ypres ([Chapter 17](#)). This provides a virtual landscape of war, a Google Earth like visualisation of both the battlefields and hinterland areas where visitors are encouraged to confront the past landscape with the present. It is anticipated that this is just the start of such developments. Technological innovations in museum exhibitions, the increasing popularity of Google Earth and other virtual worlds, and the rapid development of mobile devices and remote delivery of content, mean that the potential to take the museum into the contemporary landscape and engage the user with the (virtual) past or buried landscape through remote sensing data is achievable.

Prospects

Modern conflict archaeology as a field of practice is developing rapidly, drawing on diverse perspectives and source material, in a cross-cutting, interdisciplinary approach that has the materiality of war at its core. This volume concentrates on two broad themes – the value of the airborne perspective and the importance of landscape – developed explicitly in an interdisciplinary framework that recognises the importance of complementary sources of information, varying theoretical approaches and an integrative philosophy (Carman 2013). Given the dynamism of the field of practice and its context it is probably unwise to predict future developments, but in concluding this introductory chapter we draw attention to some issues that have struck us as we have worked on this volume.

The availability and affordability of aerial photographs varies enormously. Many collections are little known, others are locked away in military archives with heavily restricted access, still others have poor or non-existent finding aids or catalogues, while some archives are required to generate income to cover costs. Furthermore, archaeologists are among a minority of users, massively outweighed by applications such as planning and dealing with unexploded ordnance, which are better funded and may therefore attach greater priority for archives. All these factors serve to limit archaeological use of the imagery, which reduces the potential value of the photographs as sources of knowledge and understanding. There are tensions at the heart of the approaches of many archives to their collections that cut across the wish to preserve physical objects (prints, negatives) for the future, a drive for income generation and a desire, or need, to control intellectual property rights and reuse through licensing. Paradoxically, some of these agendas have probably unintended consequences in constraining use of the archival material by prioritising physical preservation or income generation over the utility of that material to understand the past and manage it effectively. The paradox lies in the question of why preservation is so important if accessibility and usage is at the same time restricted. Political and social imperatives, including the developing concepts of ‘open data’, will hopefully see accessibility improving, especially across parts of the world where there is heavily restricted access to remote sensing data. The same issues of accessibility relate to ALS data, which is unevenly available from country to country, but is made accessible (or not) under very different frameworks, ranging from basically free to download and use for any purpose, to highly controlled, expensive and with restrictive licensing that may even claim rights over derived content.

The applications of ALS in this volume demonstrate its utility, and the same is true of large-area and multi-sensor geophysical survey. However, with the advent of new technology comes the risk that such advances and new methodologies for documentation overshadow the research questions or distract attention from problem-orientated archaeological interpretation. This is a challenge to the integration of the inherently positivist approaches of

some archaeological prospection projects, whose main aim is documentation, and the theoretically-engaged, research-orientated approach of others. These are over-simplified characterisations, but at a basic level can be observed across the chapters in this volume, and to a degree reflect the different reasons for the work being undertaken. Where this is especially important for the archaeologies of modern conflict is in the potential for weaving together complex data sources in interdisciplinary contexts that move beyond documentation to providing unique perspectives that are not offered by other disciplines.

The increasingly ready availability of 3D and other digital data has already ensured that the combination of data in Geographical Information Systems (GIS) is routine archaeological practice, in which creation of digital models and other visualisations is straightforward. Increasingly, however, whether in a museum context, through Web services or via mobile devices, very much more sophisticated virtual worlds can be created, drawing, for example, on computer gaming software, and this has huge potential for different forms of engagement with past landscapes. Here, the value of further integration of the rich variety of sources for conflict landscapes is self-evident, for example in combining individual biographies, such as might be recorded in war diaries, with the contemporary landscape as recorded on historic aerial imagery, developed into a virtual environment to support research and education. Such approaches require multiple sources and inter-disciplinary working, and this is a key point for this volume: that while we have focused on particular perspectives, these are presented in the knowledge that our insights into conflict landscapes and their archaeologies are enriched by integrated theoretically aware approaches.

References

- Beylot, A. (2009) Military Aerial Photographs, from 1914 to the Present: A Survey of the French Sources. In B. Stichelbaut, J. Bourgeois, N.J. Saunders and P. Chielens (eds) *Images of Conflict: Military Aerial Photography and Archaeology*, pp. 135–50. Newcastle-upon-Tyne: Cambridge Scholars Publishing.
- Bulgrin, L.E. (2006) The Tuleda Site: Fire and Steel over Saipan, 15 June 1944. *Journal of Conflict Archaeology* 1: 1–17.
- Carman, J. (2013) *Archaeologies of Conflict*. London: Bloomsbury.
- Castrianni, L. and G. Ceraudo (2009) History of Military Aerial Photographs in Italy and Addressed Archives. In B. Stichelbaut, J. Bourgeois, N.J. Saunders and P. Chielens (eds) *Images of Conflict: Military Aerial Photography and Archaeology*, pp. 165–84. Newcastle-upon-Tyne: Cambridge Scholars Publishing.
- Cowley, D.C., L. Ferguson and A. Williams (2013) The Aerial Reconnaissance Archives: A Global Aerial Photographic Collection. In W. Hanson and I. Oltean (eds) *Archaeology from Historical Aerial and Satellite Archives*, pp. 13–30. New York: Springer.

- Cowley, D.C., R.A. Standring and M.J. Abicht (eds) (2010) *Landscapes through the Lens: Aerial Photographs and Historic Environment*, Occasional Publication of the Aerial Archaeology Research Group No. 2. Oxford: Oxbow Books.
- Cowley, D.C. and B. Stichelbaut (2012) Historic Aerial Photographic Archives for European Archaeology. *European Journal of Archaeology* 15(2): 217–36.
- Desfossés, Y. (1998) Préserver les traces. L'Archéologie et la Grande Guerre. 14–18 Aujourd'hui 2: 36–51.
- Gaffney, C., V. Gaffney, W. Neubauer, E. Baldwin, H. Chapman, P. Garwood, H. Moulden, T. Sparrow, R. Bates, K. Löcker, A. Hinterleitner, I. Trinks, E. Nau, T. Zitz, S. Tloery, G. Verhoeven and M. Doneus (2012) The Stonehenge Hidden Landscapes Project. *Archaeological Prospection* 19(2): 147–55.
- Gaffney, C., J. Gater, T. Saunders and J. Atcock (2004) D-Day: Geophysical Investigation of a World War II German Site in Normandy, France. *Archaeological Prospection* 11(2): 121–8.
- Going, C. (2009) Déjà vu All Over Again? A Brief Preservation History of Overseas Service Aerial Photography in the UK. In B. Stichelbaut, J. Bourgeois, N.J. Saunders and P. Chielens (eds) *Images of Conflict: Military Aerial Photography and Archaeology*, pp. 121–34. Newcastle-upon-Tyne: Cambridge Scholars Publishing.
- Hanson, W. and I. Oltean (eds) (2013) *Archaeology from Historical Aerial and Satellite Archives*. New York: Springer.
- Haupt, P. (2009) Great War Aerial Photographs in German Archives: A Guide to the Sources. In B. Stichelbaut, J. Bourgeois, N.J. Saunders and P. Chielens (eds) *Images of Conflict: Military Aerial Photography and Archaeology*, pp. 151–64. Newcastle-upon-Tyne: Cambridge Scholars Publishing.
- Opitz, R. and D.C. Cowley (eds) (2013) *Interpreting Archaeological Topography: Lasers, 3D Data, Observation, Visualisation and Applications*. Oxford: Oxbow Books.
- Saunders, N.J. (2002) Excavating Memories: Archaeology and the Great War, 1914–2001. *Antiquity* 76(291): 101–8.
- (2012) Introduction: Engaging the Materialities of Twentieth and Twenty-first Century Conflict. In N.J. Saunders (ed.) *Beyond the Dead Horizon: Studies in Modern Conflict Archaeology*, pp. 10–14. Oxford and Oakville, CT: Oxbow Books.
- Schofield, J. and W. Cocroft (2007) Introduction: Cold War, Diversity and Contemporary Archaeology. In J. Schofield and W. Cocroft (eds), *A Fearsome Heritage: Diverse Legacies of the Cold War*, pp. 13–19. Walnut Creek, CA: Left Coast Press.
- Stichelbaut, B., J. Bourgeois, N.J. Saunders and P. Chielens (eds) (2009) *Images of Conflict: Military Aerial Photography and Archaeology*. Newcastle-upon-Tyne: Cambridge Scholars Publishing.



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The Archaeology of World War I in Comines-Warneton (Belgium) through Aerial Photographs and Proximal Soil Sensing

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Abstract

The Western Front of World War I is one of the largest continuous archaeological sites in the world. Although fragmented archaeological surveys and inventories of related conflict heritage have been conducted, an overall landscape-scale archaeological investigation of the area has not yet been achieved. The nature and extent of the buried heritage is largely unknown. This is in spite of an increase of World War I-related excavations in Flanders during the last decade. Therefore, we have developed an integrated aerial archaeological and GIS-aided approach to assess this war heritage, and combined it with landscape research and geophysical prospection. Preliminary results suggest an excellent subsurface preservation of the conflict landscape, even after the devastating effect of the war itself and a century of reconstruction and land use. A case study at Comines-Warneton compares data derived from contemporary World War I aerial photographs with recent multi-receiver electromagnetic induction surveys. In addition, as most research traditionally has been devoted to the study of the trench systems, this chapter will focus on some of the less-studied, but equally important, aspects of the conflict landscape. These are sites such as war cemeteries, hospital sites and gun emplacements. This methodology will form the foundation for a wider study of the entire Belgian front zone – the interdisciplinary research project ‘Non-Invasive Landscape Archaeology of the Great War in Belgium’. This will combine analysis of historical aerial photographic evidence, geophysical soil sensing and historic and visual landscape analysis.

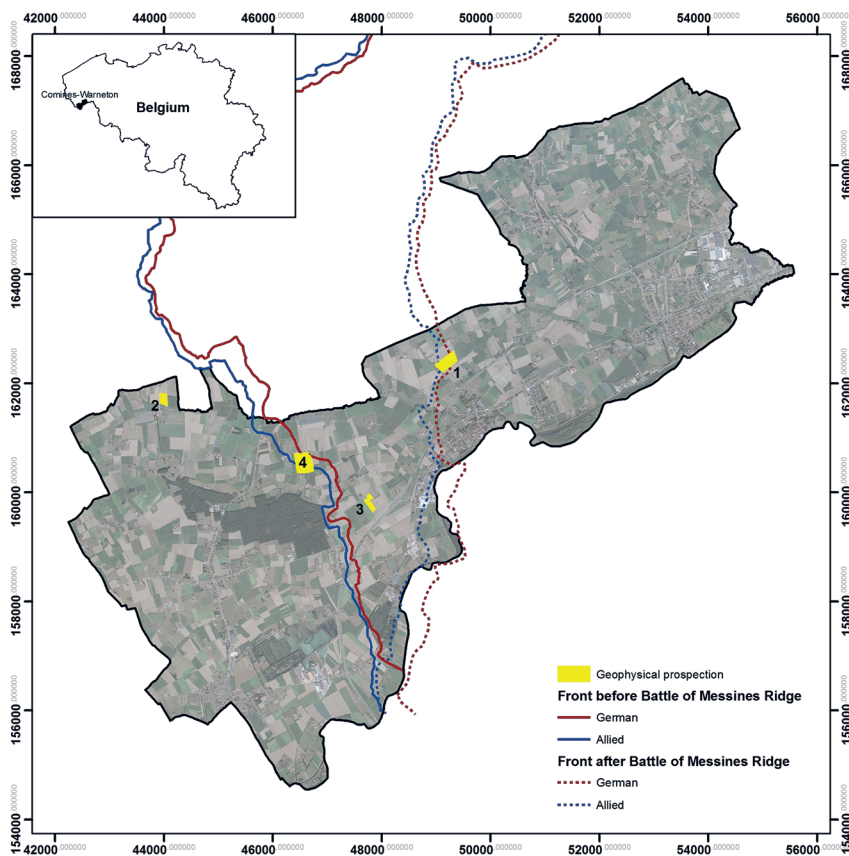
Keywords: World War I, Comines-Warneton, Western Front, geophysical research, EMI survey, landscape research.

Introduction

The Western Front extends over an area of 700 kilometres, from the Belgian coast through France to the Swiss border. This area is one of the largest continuous archaeological sites in the world, and with the centennial commemorations remembering the beginning of World War I, international academic and public attention in the site is growing. In Flanders, especially, this increased attention has prompted a growth in archaeological excavations into the traces left by World War I (for an overview, see Van Hollebeeke et al. 2014). Inevitably, questions about the presence, nature, diversity and value of this heritage are raised by such excavations, alongside practical considerations such as the need for the preservation of such remains, and their treatment during infrastructure developments (agriculture, industry, and urban expansion). Such complex questions cannot be answered solely through traditional archaeological field investigations, but require an interdisciplinary non-invasive approach conducted on a landscape scale.

To meet the need for scientific research on the material remains of World War I in Belgium, we have developed an integrated aerial photographic and GIS-aided (Geographical Information Systems) approach (Gheyle et al. 2014, Stichelbaut 2009). Historical aerial photographs are an excellent source when studying the war landscape. This is all the more true if the results are combined with archaeological field surveys detailing above-ground remains, alongside non-invasive geophysical research that gives an idea of the archaeological preservation under the topsoil. Our approach combines three dimensions into one dataset: first, a birds-eye view of the situation in 1914–18; second, the present-day landscape scattered with remains (from military cemeteries and pillboxes to subtle micro-topographic traces); and finally a detailed view of preserved subsurface features such as trenches and bunkers.

Traditionally archaeological attention has been focused on trench systems – perhaps the most iconic symbols of the stalemate and *Materialschlacht*, together with the bunkers and shell holes (Dewilde et al. 2007, Masters and Stichelbaut 2009, Masters this volume, Osgood and Brown 2009, Robertshaw and Kenyon 2008, Saey et al. 2013a, Stichelbaut et al. in press). However, the impact of the conflict was not limited to the frontline itself, but extended across an area of over 30 kilometres on both sides of the combat zone (Stichelbaut 2011). German and Allied artillery positions, military camps, training zones, hospitals, military cemeteries, airfields, ammunition depots and other sites in the hinterland are equally important for understanding the war landscape – the archaeology of a conflict landscape cannot be limited to the archaeology of the battlefield (Saunders 2013). Therefore, this study focuses on aerial photographic and geophysical research focused on some of those less-studied aspects of the conflict landscape, such as war cemeteries, hospital sites and gun emplacements. This is illustrated with a case study of Comines-Warneton, a Walloon municipality located on the former Western Front between West-Flanders and France (Figure 1.1).



1.1 Location of Comines-Warneton along the Belgian front and indication of the fields surveyed with electromagnetic induction sensor (EMI). 1: Quatre-Rois, 2: La Plus Douve, 3: Chemin des Loups, 4: Chemin du Mont de la Hutte. © authors and AGIV: orthophoto mosaic 2009

Historical Context

Comines-Warneton is located south of the infamous Ypres Salient, on the southern part of the Messines Ridge. After the British troops lost this strategic ridge to the Germans on 1 November 1914 (Edmonds 1925: 303–12) the front area stabilised for two and a half years and two parallel trench systems developed on each side of a narrow no man's land. In 1916, preparations were made to launch an Allied offensive on the Messines Ridge; these preparations included 21 offensive mines dug deep beneath key German positions (Institution of Royal Engineers 1922). In the early morning of 7 June 1917, the Battle of Messines began. Nineteen deep mines (four of which lie within the study area) were detonated, and a large-scale infantry attack followed immediately. The German first line of defence crumbled and Australian and New Zealand troops pushed the German defenders back some 3 kilometres. However, all this captured terrain was lost again in April 1918 when the Germans launched their Spring Offensive. The area would stay in German hands until the final offensive of September 1918.

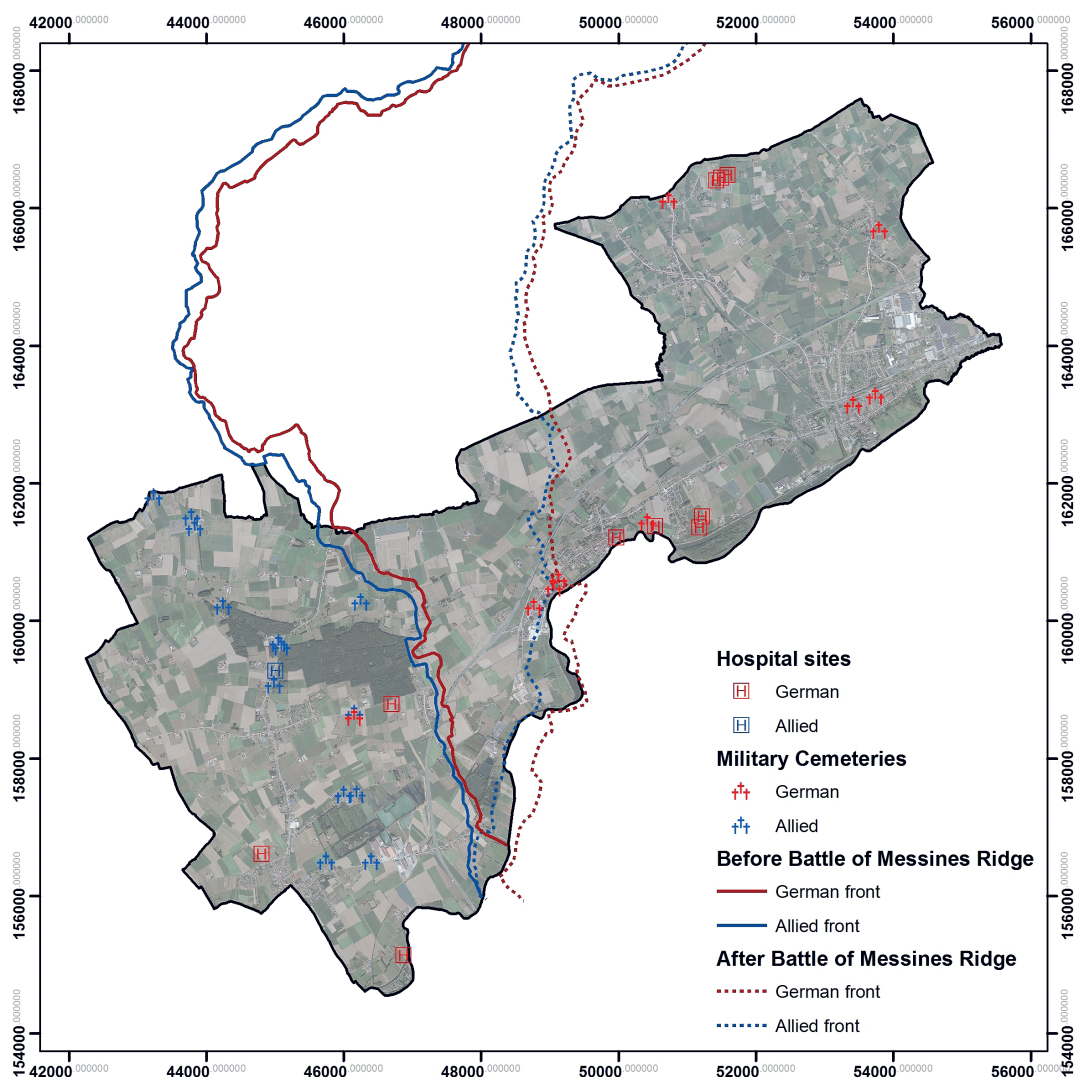
Data Acquisition and Methodology

From the end of 1915 aerial photo-reconnaissance units operated along the Western Front on a regular basis in order to record enemy defences (Carrier 1921). The Comines-Warneton study area was captured by thousands of historical aerial photographs. A selection comprising 1,628 of these vertical images, taken between 4 February 1915 and 9 October 1918, were used for this study. These photographs were integrated in a GIS and all visible traces were mapped in detail. An extensive field survey was conducted in order to locate remains (that is pillboxes, tunnel entrances and preserved trenches) that still survive above the surface (Stichelbaut et al. 2015). In addition, four selected areas (a total of 30 hectares) were surveyed with geophysical sensors to explore the character and preservation of subsurface archaeological remains (see below).

The compilation of large numbers of aerial photographs in a GIS allows for the information from individual photographs to be translated into a landscape scale of research. The GIS inventory for Comines-Warneton contains up to 13,681 individual war features (Stichelbaut et al. 2015), including trenches, pillboxes, barracks, ammunition dumps, narrow-gauge railways, fortified shell holes and buried communication cables. A detailed analysis and description of all feature categories is beyond the scope of the present chapter, and while Stichelbaut et al. (in press) discuss the trenches and pillboxes in Comines-Warneton in detail, this chapter concentrates on hospital sites, military cemeteries and artillery emplacements, features which are often overlooked.

The study of the aerial photographs gives us a very detailed overview of most war-related infrastructure, and often provides unique information. The resulting GIS layers and database depict the conflict landscape in great detail, and show where possible archaeological or above-ground remains of World War I might be expected today. What the photo-interpretation cannot tell is the degree of preservation of detected features. Structures may be preserved above ground, such as some pillboxes, or trenches and other earthworks in mostly wooded areas. But most areas are arable land and pasture that have been cultivated for over a century. In order to evaluate the character of the buried heritage in the area of Comines-Warneton, 30 hectares of geophysical survey was conducted (see [Figure 1.1](#)) with the following aims: validating the photo-interpretation data using non-invasive prospection techniques; evaluating the degree of preservation of all different types of military infrastructure; comparing the results of photo-interpretation and geophysical survey (for example dugouts or camouflaged positions); and evaluating the use of geophysical prospection methods for World War I archaeology.

The results from Plus Douve, one of the four selected zones, are elaborated below. This site proved to be an excellent example of the elaborate gun emplacement positions constructed during the war, while also illustrating the added value of geophysical survey in combination with historical aerial photographs.



Hospital Sites and Military Cemeteries in Comines-Warneton

A number of aerial photographs show hospital sites and military cemeteries, silent witnesses to the immensity of human suffering during the war. Where aerial photographs often put the subject of the photograph – literally and figuratively – at a certain distance, these testaments to injury and death bring the invisible men in the photographs closer to us. They enable us to speak of a human history behind the seemingly distant black and white imagery and desolate landscapes.

Twenty-two military cemeteries have been identified on the aerial photographs surveyed (Figure 1.2), although their original number would have been higher. Due to the scale of the images some cemeteries, consisting of only a small, nondescript row of graves, are not detectable. Time series of

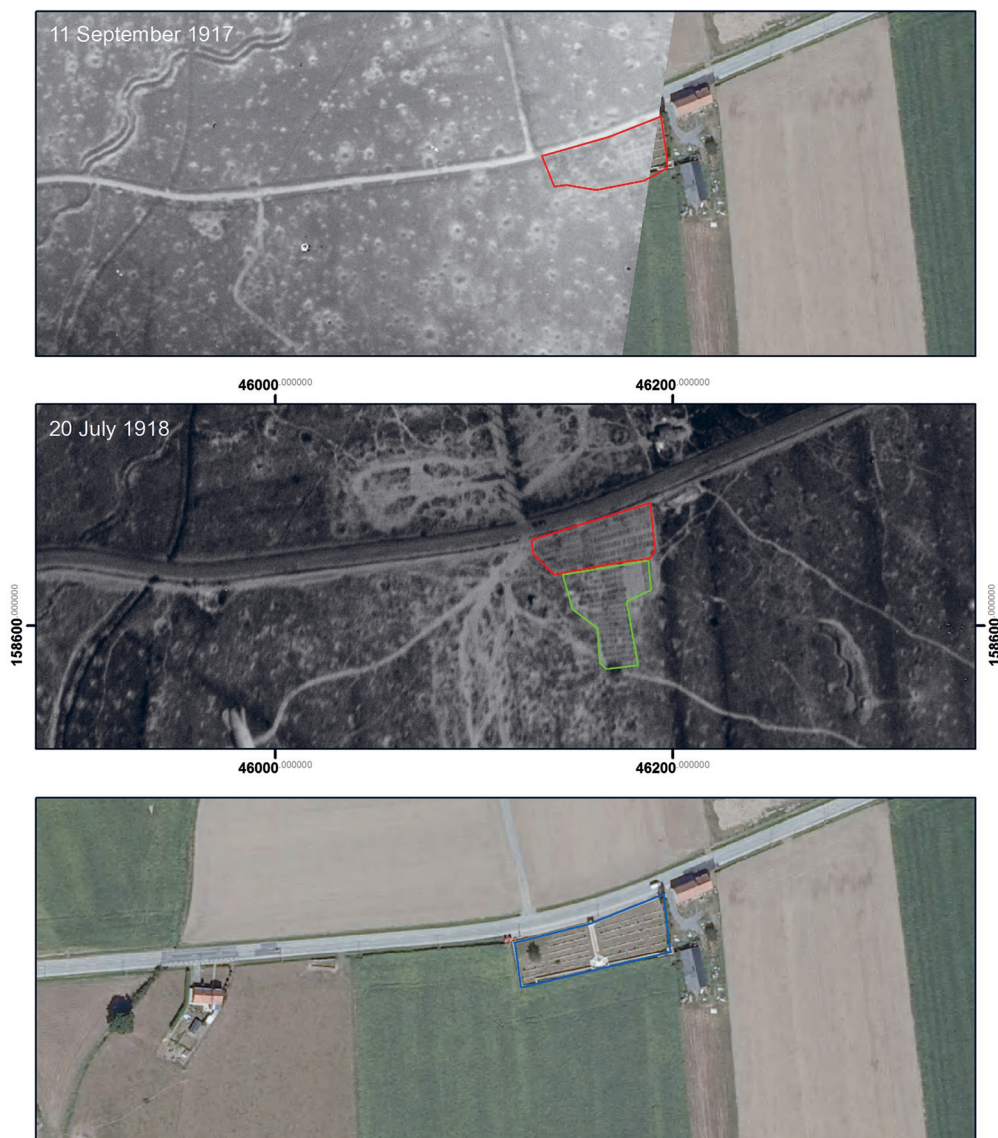
1.2 Location of military cemeteries and field hospitals in Comines-Warneton, as detected on the World War I aerial photographs.
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aerial photographs allow us to follow the evolution of especially the larger cemeteries in great detail. Thirteen of the allied cemeteries identified in these photographs, such as Prowse Point Cemetery and St Quentin Cabaret Military Cemetery, still exist today. These are so-called 'original' cemeteries, already in use during the war. On the German side the present-day situation is different, and none of the nine observed German wartime cemeteries have survived to the present. Most of the original German cemeteries were cleared between 1924–32 and 1955–8 (Dendooven 2006), with the remains reburied in one of the four large German 'collecting' or 'concentration' cemeteries in Langemark, Vlaslo, Menen and Hooglede. The historic aerial images form a privileged source of information on the former German funerary war landscape (see also Stichelbaut and Chielens 2013: 78–9). In these photographs, German cemeteries are easily recognisable by their strict layouts and geometric motifs, including cruciform pathways and typical commemorative monuments. On particularly detailed images one can even discern individual gravestones.

A striking example of the value added by aerial imagery regarding funerary sites is Lancashire Cottage Cemetery, just south of Plugstreet Wood. This cemetery was established as early as the First Battle of Ypres and lays just behind the Allied frontline. From November 1914 onwards, casualties from the 1st East Lancashire and 1st Hampshire Regiment were buried here (Commonwealth War Graves Commission 2014). On some of the aerial photographs the individual graves of the original British cemetery are visible. By September 1917 it encloses an area of about 50 metres by 22 metres. During the Spring Offensive of April 1918 the Germans were able to push westwards and capture almost all the territory of Comines-Warneton. Interestingly, however, the photographs indicate that the cemetery, by this time located behind German lines, continued to be in use (Figure 1.3). A British aerial photograph taken on 20 July 1918 shows clear activity on the cemetery, with expansion to the south and a more than doubling of its area. After the war the German bodies were exhumed and reburied elsewhere, and the British cemetery was reorganised by the Commonwealth War Graves Commission. For reasons unknown, 13 German soldiers were left on the south side of the cemetery. However, the *genius loci* changed drastically and the remembrance of the German phase of its history was largely erased.

Unsurprisingly there is a strong link between hospitals and military cemeteries, as those that did not survive their injuries were buried in the direct vicinity. Along the Allied and German medical evacuation routes a vast network of military cemeteries developed. Close to the front military cemeteries emerged that were mostly small and short-lived, connected as they were to small first-aid posts, or developed as a product of battlefield burials. Away from the frontlines the original wartime cemeteries are bigger, as they were connected with larger hospital sites.

Strand Military Cemetery was a frontline cemetery linked to a medical post that was established in November 1914, but was mainly used from May to July 1917 (Commonwealth War Graves Commission 2014). On a British aerial photograph taken on 11 September 1917, several faint marks can be seen which indicate the turned ground of recently added graves (Figure 1.4).



1.3 Time series of aerial photographs showing the evolution of Lancashire Cottage Cemetery. Red: British cemetery; green: extension; blue: present-day coverage of the cemetery with the German graves. © IWM Box Collection – Box 236 1927 42B 28U 1917 and Box 207 306 206K 28U 1918; AGIV: orthophoto mosaic 2009



1.4 Strand Military Cemetery, comparison between 11 September 1917 and 2009. © IWM Box Collection – Box 236 1929 42B 28U 1917; AGIV: orthophoto mosaic 2009

The field hospital is visible only 150 metres away, and between some ruined farm buildings and two barracks there is a Red Cross emblem which is clearly visible. From here, different traces leading towards the graveyard indicate active traffic. The aerial photograph provides us with a narrative about this place that cannot be obtained from any other source of information. The cemetery also continued to evolve and grow after this moment in time, as a comparison with a present-day aerial photograph shows. After the war, Strand Military Cemetery became a so-called ‘collecting’ or ‘concentration’ cemetery, where the remains of identified and unknown soldiers were brought together from several smaller cemeteries or individual plots in the region between Wijtschate (West-Flanders) and Armentières (northern France).

Gun Emplacements in Comines-Warneton

Another feature that is underrepresented in archaeological studies of conflict landscapes is artillery emplacements. World War I introduced artillery fire on an unprecedented scale and locating enemy gun positions quickly became one of the main goals of aerial reconnaissance. Most of the batteries

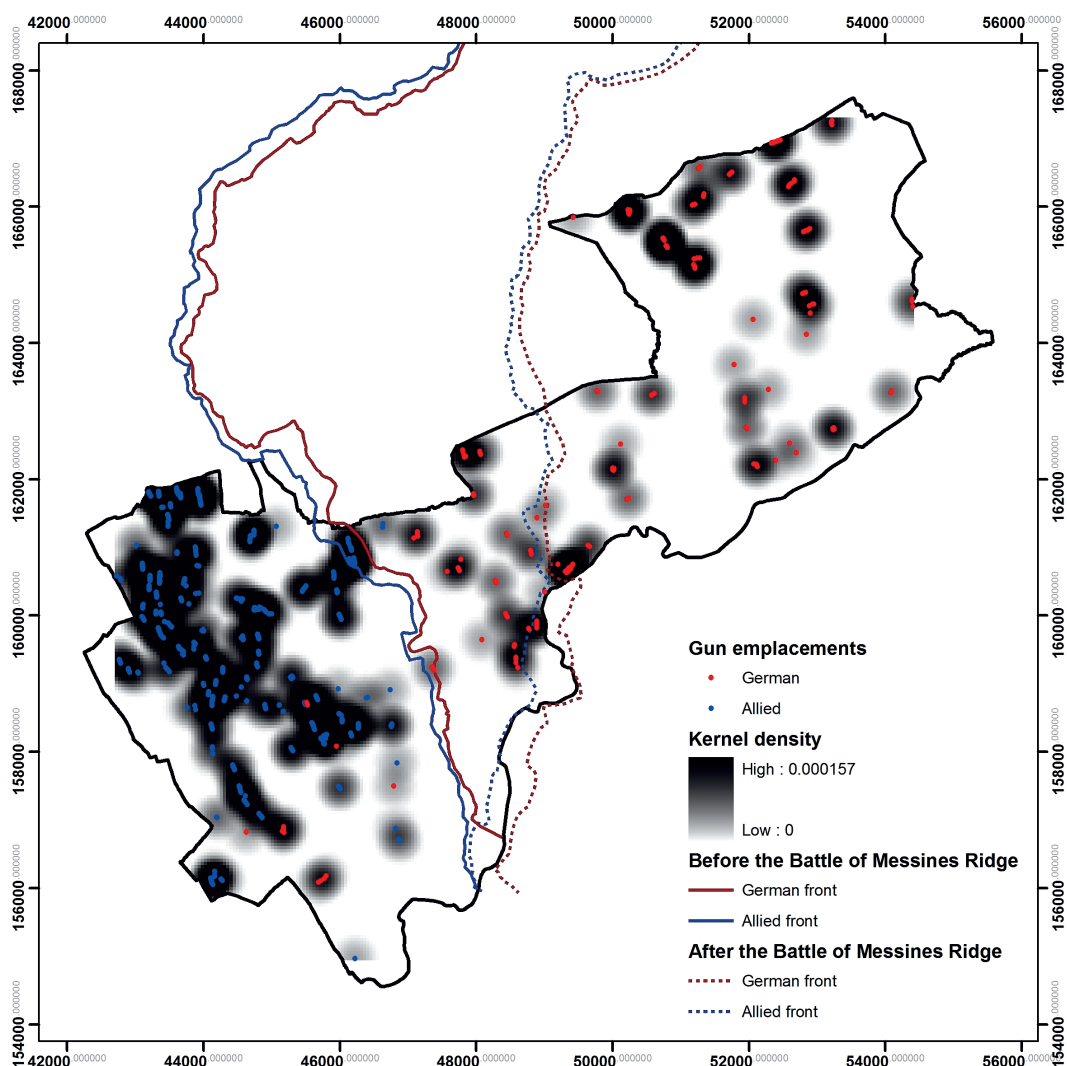
were permanent or semi-permanent installations with extensive defensive works, which make them relatively easily detectable on the photographs – although camouflage could be very effective. Nevertheless, they are not well documented in recent archaeological excavations, as either their footprint in the soil appears to be quite limited, or they are difficult to interpret. This was noticed during excavations in Wervik (Gheysen 2008). Other reasons gun emplacements might have received little previous attention include not being considered properly in predetermined research goals, as was encountered at excavations at Middelkerke – Groot Tempelhof (Zeebroek et al. 2006).

Photo interpretation indicates that the majority of the batteries consist of two types: an open-air gun position with a horseshoe shaped embankment (n=220), or secondly a completely protected gun position under a wooden, earthen, brick or concrete construction (n=278). Most of the artillery emplacements in Comines-Warneton are of Allied origin (n=284 + 126 possible gun emplacements) (Figure 1.5). Both spatially and chronologically, they are related to the Battle of Messines Ridge, with 291 of them dating from May, June and July 1917. The German gun positions appear to be less numerous (n=144 + 49 possible gun emplacements), but might well be underrepresented in the aerial photographic records as historical sources point out that many of the batteries were very well camouflaged (Bean 1938: 93). Archaeologically, these structure types are not well known, but geophysical research in the study area can add some interesting information, as will be illustrated by a case study at Plus Douve (Ration Farm) in Ploegsteert (Comines-Warneton).

Plus Douve: Combining Aerial Photographic Evidence and Geophysical Survey

The geophysical prospection was undertaken on south-sloping ground bounded by the Douve stream over an area of 3 hectares. During the greater part of the war, this zone was located about 750 metres behind the Allied frontline. The information from photo-interpretation shows a great range of military activity including different trenches, a series of (camouflaged) gun emplacements, several dugouts and a narrow-gauge railway (features are alphabetically identified in the text below and labelled in the following figures).

The site is covered by 12 aerial photographs taken between March 1916 and July 1918, and this is complemented by about 50 trench maps that show the site in more or less detail. The earliest map dates from 21 April 1915 and only shows an east-west oriented fighting trench (a). At that time, the trench was a second line position, strategically positioned on the southern slope and concealed from direct enemy observation. The trench is out of the ordinary because there are dozens of short, perpendicular stretches of trench that are connected to it (b) in a pattern that is hard to interpret. It is possible that they are entrances. It is also possible when considering the sloping terrain that they were dug to drain the trench.



1.5 Spatial distribution of Allied and German gun emplacements in Comines-Warнетon, with an indication of the density, as detected on the World War I aerial photographs.
© authors

Figure 1.6 shows the area in September 1916. Not only are the fighting trench (a) and short annexes (b) clearly visible, but also an elongated feature some 60 metres in length (c) that appears to be an embankment with a series of entrances from the west. Very likely, these are a series of earthen dugouts. From one of the short annexes (b), a very thin line can be traced southwards (d), possibly a buried communication cable. An additional zigzag communication trench (e) extends across the central part of the field. This situation remains largely unaltered until April 1917 (Figure 1.6).

The interpretation of the long feature (c) is confirmed by an annotation on a German trench map (Meesen Nord Deckblatt 6; 14 April 1917) that suggests this feature is an *Unterstand* (U) or shelter. The same map has the earliest indication of a north-south orientated fighting trench with typical right-angled traverses (f), also visible in overview Figure 1.7 (upper left).

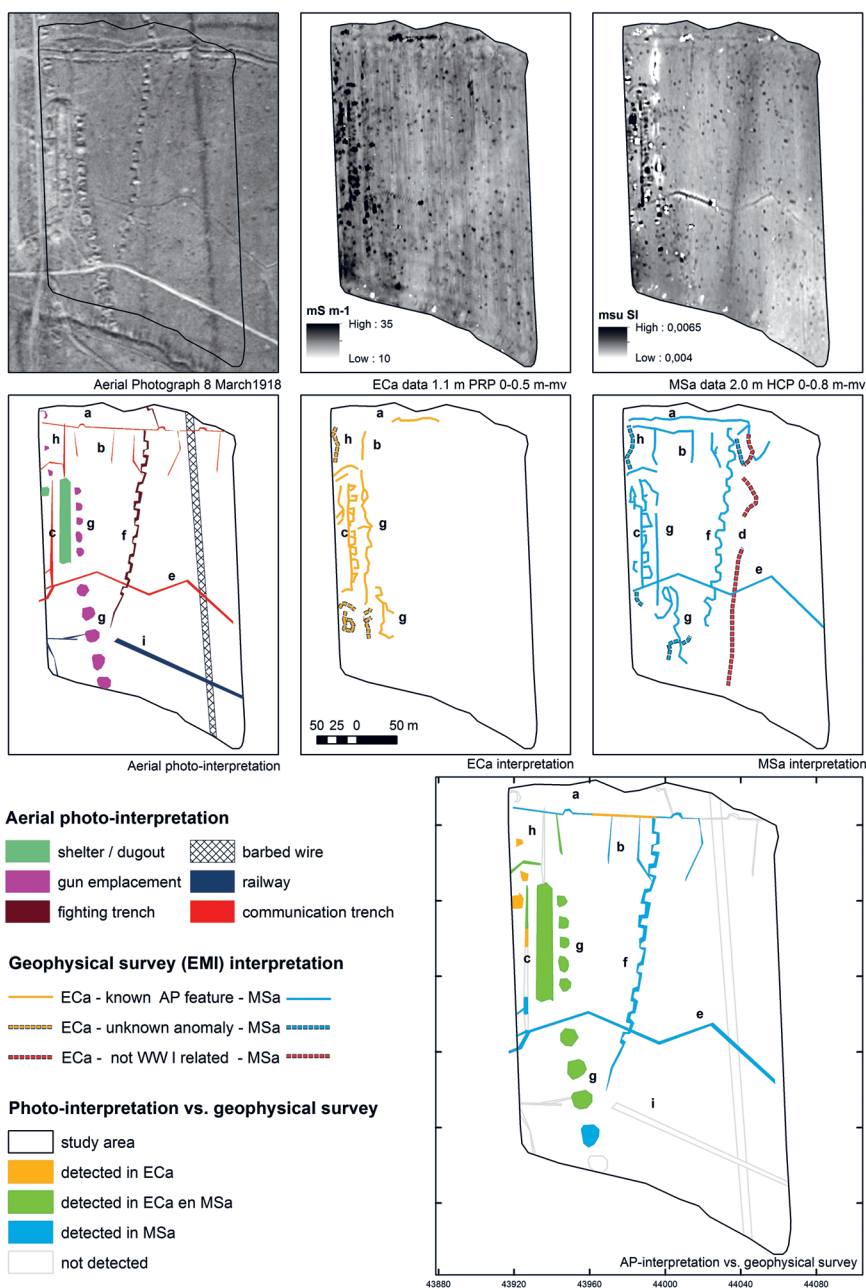


Increasing activity in the area is evident on imagery from May and June 1917, corresponding with the build-up to the Battle of Messines Ridge (7 June 1917). Although heavily camouflaged, we see a series of gun positions (g) on a German aerial photograph from 26 May 1917. The battery is composed of a dozen individual artillery positions, identifiable by the dark spots of about 7 metres square. Despite the camouflage, their location is betrayed by paths that run towards and alongside the gun positions. The location of this battery is again closely related to the local topography, lying beyond the line of sight of German ground observation.

On 18 October 1917, the date of the next photograph covering the area, the battery is no longer in use and the camouflage has been removed (Figure 1.7, top left). The image shows some additional gun positions in the north-western part of the surveyed area (h) as small, horseshoe-shaped embankments. We also see a narrow-gauge railway in the southern part of the field (i) that was constructed just after the battle in the summer of 1917 to ensure sufficient supplies for the advanced Allied frontline.

The German Spring Offensive of April 1918 pushed back the Allies far beyond the former frontlines of 1915–17 and the area became part of the German hinterland. Although no new trenches or gun positions were constructed, contemporary trench maps suggest that at least some of the Allied structures were incorporated in the German military infrastructure.

1.6 British aerial photograph (28 September 1916) of the study area with a fighting trench from 1915 (a) and annexes (b), a series of dugouts (c), a possible communication cable (d) and an already filled-in zigzag communication trench (e). © IWM Box Collection – Box 66 37 1BT 28T 1916; AGIV: orthophoto mosaic 2009



1.7 Overview image of the study area with aerial photo-interpretation and geophysical survey.

Top row: British aerial photograph and EMI survey data (ECa and MSa measurements). Middle row: interpretation of the aerial photographs and interpretation of the ECa and MSa measurements.

Bottom row: combination of photo-interpretation with geophysical data, giving an indication of detected (and thus at least partially preserved) and non-detected (and thus possibly non-preserved) war features. © IWM Box Collection – Box 201 289 X3BA 28T 1918 and authors

Geophysical Survey with a Multi-receiver EMI Sensor

To evaluate the potential archaeological remains with non-invasive techniques the 3-hectare field at Plus Douve was surveyed with a multi-receiver electromagnetic induction (EMI) sensor. The EMI sensor is primarily sensitive to variations in apparent soil electrical conductivity (ECa) and apparent magnetic susceptibility (MSa) (Saey et al. 2013b), and has proved successful in characterising the nature of soil material (that is texture, moisture and organic content) and some types of anthropogenic material (fire places, bricks and metal).

The DUALEM-21S EMI sensor (DUALEM, Milton, Canada) was used, which consists of one transmitter coil and four receiver coils located at intervals of 1.0, 1.1, 2.0 and 2.1 metres. The sensor allows simultaneous measurement of ECa and MSa and the coils have two different orientations (horizontal and perpendicular). The 1.0 and 2.0 metre transmitter-receiver pairs form a horizontal coplanar dipole mode (HCP), while the 1.1 and 2.1 metre pairs form a perpendicular dipole mode (PRP). Together with the separation of transmitter and receiver coils, these different coil orientations determine the depth and weighting response pattern of the signal (Saey et al. 2009).

The depth of investigation (DOI) of a coil configuration is generally considered to be the depth where 70 per cent of the cumulative response originates from the soil volume above that point. By filtering this response out of the data, we can determine that the dominant response depths for the ECa measurements vary from 0.5 metre (1.1 metres PRP), over 1.0 metre (2.1 metres PRP) and 1.6 metres (1.0 metre HCP), to 3.2 metres (2.0 metres HCP) below the sensor – thus information is gathered from different soil volumes up to a depth of 3 metres. The DOI is less straightforward to calculate for the MSa, due to the complexity of the depth response curves associated with the different coil configurations.

The EMI sensor was pulled on a non-metal sled by an all-terrain vehicle at a speed of about 5–8 kilometres per hour, crossing the field in parallel lines spaced 1.4 metres apart giving measurement intervals of approximately 0.2 metres.

Plus Douve: Prospection Results

The ECa measurement of the 1.1 metre PRP coil configuration (1.7) shows a clear anomaly within the western part of the field. This is partly caused by a large quantity of metal objects in the subsoil, and partly because these objects are connected by subtle linear features caused by digging and consequent filling with contrasting material. Presumably, these features represent the dugouts (c) and gun positions (g) that were detected on the aerial photographs. In particular the structure of the anomaly of the dugouts (c) provides new information about the internal organisation of this originally dug-in and heavily camouflaged structure, which on the aerial photographs only shows up as one large, amorphous building.

Compared to other study areas along the frontline, this site clearly contains fewer metal fragments within the subsoil. In the central part of the field a linear structure composed of a sequence of very strong positive and negative anomalies can be interpreted as a buried communication cable at the bottom of the zigzag communication trench (e). This ends halfway along the trench with a strong magnetic signal, possibly a larger metal object such as a switch box or radio set, or a coil of unused cable. In the northern part of the site, the fighting trench (a) with short annexes (b) is also clearly distinguishable.

The presence of large concentrations of buried metal objects is less apparent from the ECa measurements of the other coil configurations (not illustrated), but there are similarities within the northern part of the study area (trench (a)) and the western part (dugouts (c) and gun emplacements (g)), where buried metal heavily influences the signal. The 1.0 metre HCP coil configuration shows fewer metal fragments in the top soil, and these are assumed to lie mainly just below the topsoil. On the 2.0 metre HCP configuration data, a zigzag communication trench is visible (e). In the centre of the field there is a north-south orientated zone with lower conductivity. The ECa 1.0 metre PRP measurements appear to indicate the artillery battery (g). This survey indicates that all described features are still present in some form below the topsoil.

The MSa measurements confirm the results from the ECa data, but also provide additional information (Figure 1.7). The 1.0 metre HCP coil configuration indicates some extreme anomalies caused by metal objects within the topsoil. The gun battery in the western part of the field (g) is easily distinguished on the 2.0 metre HCP configuration, meaning that the remains of this battery will be situated mainly just below the plough layer. Both the outline and the internal configuration of the gun positions can be traced in detail. A north-south oriented fighting trench is visible in the central part of the field (f) as a subtle feature, but is certainly preserved below the topsoil. East of this feature, and parallel with it, there is a zone with higher magnetic susceptibility, probably caused by a small ditch that was filled in with topsoil. Looking back at the aerial imagery, a possible interpretation could be a trench for a communication cable, but this feature was so unclear that it was not included in the GIS-database (d). There is no buried cable preserved today, as no metal anomalies show up in the measurements, and the feature might well be not related to the war at all. As in the ECa measurements, but even stronger here, we see the zigzag communication trench (e). In the south-western part of the area, there are different strong or extreme anomalies that point to the presence of buried metal. Possibly they represent several individual gun positions (g).

Aerial Photographs and Geophysics Combined

Previous research has established that it is possible to detect trench systems with geophysical techniques, and that most trenches visible on the World War I aerial photographs are still visible in present-day geophysical data –

and thus at least partly preserved within the subsoil (Masters and Stichelbaut 2009, Stichelbaut et al. 2011). The prospection in Plus Douve was specifically undertaken to determine if smaller, less distinct features are evident and to determine the degree of their preservation. The survey of about 3 hectares also enables us to compare the aerial photographic and geophysical datasets. A highly quantitative approach will lead to a better understanding of the preservation of features and also enables us to evaluate the methodology.

The descriptions of the ECa and MSa datasets prove that remains of most features still survive under the plough soil. A total of 610 metres of anomalies were detected in the ECa data, most (509 metres) of which relate to features visible on the aerial photographs. However, some more detailed features (101 metres) north and south of the artillery emplacement (c) suggest extra features that were not clearly visible on the photos (dotted lines in [Figure 1.7](#)). The MSa dataset shows more anomalies (1,312 metres), and most of these are directly related to features on the aerial imagery (1,058 metres). Possible additional anomalies (93 metres) are similar to the ECa data and lie north (h) and south of the gun battery (c). An indistinct feature running north-south in the centre of the field (d) is possibly not related to World War I (161 metres, red dotted line in [Figure 1.7](#)).

The comparison of aerial photo-interpretation and geophysical survey can also tell us something about the possible degree of preservation of features ([Figure 1.7](#)). The assumption is that the aerial photographs give us a comprehensive view of the major war features. In total some 1,007 metres of line features (trenches and narrow-gauge railways), 15 point features (bunkers, shelters and gun emplacements) and 1,135 square metres of barbed wire entanglements were identified on the aerial photographs. A minority of the line features are surface structures that have almost no potential to leave archaeological traces, such as narrow-gauge railways (184 metres). As is also the case with the barbed wire entanglements, these were cleared shortly after the war or destroyed during restitution of agricultural land, and they are excluded from the comparison.

The research in Plus Douve confirms the high potential for preserved trenches, with up to 89 per cent of the fighting and 76 per cent of the communication trenches detected by the EMI survey (187 metres and 469 metres). A comparable proportion (87 per cent) of gun positions and shelters appear to be preserved beneath the plough layer. On average, about 84 per cent of the original constructions with an impact in the soil of the 1914–18 battlefield have been detected and are thus preserved in the present-day soil archive to some degree at least. Moreover, 194 metres of previously unknown anomalies were detected, completing the view of the conflict landscape in Plus Douve.

Conclusion and Future Perspectives

The case studies of Comines-Warneton and Plus Douve highlight the diversity of archaeological war heritage in the front area in Belgium. Geophysical prospection with a multi-receiver EMI sensor proved to be a useful validation

method for the potential of preserved archaeological remains, building on the interpretation and detailed delineation of the features from aerial photo-interpretation. In addition, proximal soil sensing can give a clear image of the internal organisation of specific types of structures that are difficult to interpret from historical aerial imagery. It can also detect additional features that were not visible on the aerial photographs because they were thoroughly camouflaged or were not covered by any of the images due to a limited lifespan (in between two available photographs) or a construction date after the last available image.

A recently initiated research project funded by the Ghent University Special Research Fund (Concerted Research Action) is planning to expand on these themes. The project 'Non-Invasive Landscape Archaeology of the Great War' proposes a novel combination of non-destructive technologies for mapping and characterising the conflict landscape of World War I, including aerial photo-interpretation, geophysical prospection and a study of the landscape and its dynamics. A landscape archaeological analysis is required to explore the complex interaction between human activities and the physical environment, and to understand the link between war activities and the landscape in which they took place.

Acknowledgements

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References

- Bean, C. (1938) *Official History of Australia in the War of 1914–1918*. Volume IV: *The Australian Imperial Force in France 1917*. Sydney: Angus & Robertson.
- Carlier, A. (1921) *La photographie aérienne pendant la Guerre*. Paris: Librairie Delagrave.
- Commonwealth War Graves Commission (2014) *Commonwealth War Graves Commission website*. <http://www.cwgc.org> (retrieved 14 November 2014).
- Dendooven, D. (2006) Het herdenken van de doden: begraafplaatsen en monumenten. In P. Chielens, D. Dendooven and H. Decoodt (eds) *De laatste getuige. Het oorlogslandschap van de Westhoek*, pp. 103–10. Tiel: Lannoo.
- Dewilde, M., M. de Meyer and N.J. Saunders (2007) Archeologie van de 'Groote Oorlog'. De Vlaamse situatie. *Monument, Landschappen en Archeologie* 26: 37–54.

- Edmonds, J. (1925) *History of the Great War. Military Operations: France and Belgium, 1914. Volume II: Antwerp, La Bassée, Armentières, Messines and Ypres, October – November 1914*. London: Macmillan.
- Gheyle, W., R. Dossche, J. Bourgeois, B. Stichelbaut and V. Van Eetvelde (2014) Integrating Archaeology and Landscape Analysis for the Cultural Heritage Management of a World War I Militarised Landscape: The German Field Defences in Antwerp. *Landscape Research* 39: 502–22.
- Gheysen, K. (2008) *Proefsleuvenonderzoek Wervik – Kruiseke*. Unpublished Report. Brussels: Agentschap RO-Vlaanderen.
- Institution of Royal Engineers (1922) *The Work of the Royal Engineers in the European War, 1914–19: Military Mining*. Chatham: Mackay & Co.
- Masters, P. and B. Stichelbaut (2009) From the Air to Beneath the Soil: Revealing and Mapping Great War Trenches at Ploegsteert (Comines-Warneton), Belgium. *Archaeological Prospection* 16: 279–85.
- Osgood, R. and M. Brown (2009) *Digging up Plugstreet: The Archaeology of a Great War Battlefield*. Yeovil: Haynes Publishing.
- Robertshaw, A. and D. Kenyon (2008) *Digging the Trenches: Archaeology of the Western Front*. Barnsley: Pen & Sword Military.
- Saey, T., D. Simpson, H. Vermeersch, L. Cockx and M. Van Meirvenne (2009) Comparing the EM38DD and DUALEM-21S Sensors for Depth-to-Clay Mapping. *Soil Science Society of America Journal* 73: 7–12.
- Saey, T., B. Stichelbaut, J. Bourgeois, V. Van Eetvelde and M. Van Meirvenne (2013a) An Interdisciplinary Non-invasive Approach to Landscape Archaeology of the Great War. *Archaeological Prospection* 20: 39–44.
- Saey, T., M. Van Meirvenne, P. De Smedt, W. Neubauer, I. Trinks, G. Verhoeven and S. Seren (2013b) Integrating Multi-receiver Electromagnetic Induction Measurements into the Interpretation of the Soil Landscape around the School of Gladiators at Carnuntum. *European Journal of Soil Science* 64: 716–27.
- Saunders, N.J. (ed.) (2013) *Beyond the Dead Horizon: Studies in Modern Conflict Archaeology*. Oxford: Oxbow Books.
- Stichelbaut, B. (2009) *World War One Aerial Photography: An Archaeological Perspective*. Unpublished PhD. Ghent: Department of Archaeology UGent.
- (2011) The First Thirty Kilometres of the Western Front 1914–1918: An Aerial Archaeological Approach with Historical Remote Sensing Data. *Archaeological Prospection* 18: 57–66.
- Stichelbaut, B. and P. Chielens (2013) *In Flanders Fields: The Great War Seen from the Air*. Brussels: Mercatorfonds.
- Stichelbaut, B., T. Saey, F. Meeuws, J. Bourgeois and M. Van Meirvenne (2011) World War One Heritage in Belgium: Combining Historical Aerial Photography and EMI. In D.C. Cowley (ed.) *Remote Sensing for Archaeological Heritage Management*. EAC Occasional Paper No. 5 / Occasional Publication of the Aerial Archaeology Research Group No. 3, pp. 265–73. Budapest: Archaeolingua.
- Stichelbaut, B., Y. Van Hollebeeke and J. Bourgeois (in press) Comines-Warneton: 1914–2014: A Landscape Approach. In K. Reeves, G. Bird, L. James, B. Stichelbaut and J. Bourgeois (eds) *Battlefield Events: Landscape, Commemoration and Heritage*. Abingdon: Routledge.

- Stichelbaut, B., Y. Van Hollebeeke, T. Saey, W. Gheyle, M. Van Meirvenne and J. Bourgeois (2015) *Comines-Warneton 1914–2014. Inventaire de l'archéologie de la Première Guerre mondiale à Comines-Warneton. Photographies aériennes, prospections géophysiques et monuments*. Unpublished report. Ghent: Department of Archaeology UGent.
- Van Hollebeeke, Y., B. Stichelbaut and J. Bourgeois (2014) From Landscape of War to Archaeological Report: Ten Years of Professional World War I Archaeology in Flanders (Belgium). *European Journal of Archaeology* 17: 702–19.
- Zeebroek, I., G. Jansseune, D. Tys and M. Pieters (2006) Het Groot-Tempelhof te Slijpe, de oude Commanderie de Flandre van de orde van de tempelridders (gem. Middelkerke, prov. West-Vlaanderen). Geïntegreerde analyse van het landschap, archiefbronnen en opgravingsresultaten 1971–2003. *Relicta. Archeologie, Monumenten- en Landschapsonderzoek in Vlaanderen* 1: 155–82.

Bellewaarde Ridge (Belgium): Survey of a World War I Landscape

Marc Dewilde, Hilde Verboven and Franky Wyffels

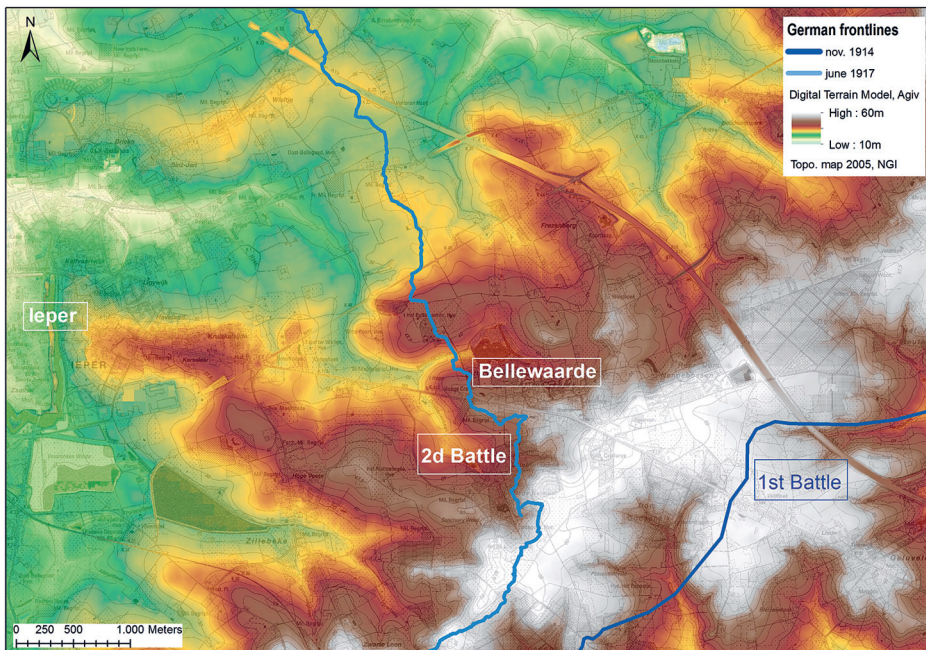
Abstract

During World War I Bellewaarde Ridge, an infamous location in the Ypres Salient (Belgium), was a heavily contested landscape. During the war of movement in 1915 the area witnessed the use of gas, but soon developed into an extended stalemate punctuated by attempts to break the opposition through underground mine warfare. This chapter presents an integrated programme of archaeological research on the Bellewaarde Ridge, which combined trial trenching and geophysical research with the study of trench maps and aerial photographs.

Keywords: World War I, conflict archaeology, geophysics, Flanders, Ypres Salient, Bellewaarde Ridge.

Introduction and Historical Context

Today there is an amusement park at Bellewaarde, with the thrills of the rollercoaster, the excitement of the zoo, entertainment and children playing. The contrast with the situation a century ago could not be greater. In wartime, Bellewaarde meant danger, fierce fighting and possibly death – definitely a place to be avoided. During the First Battle of Ypres (October to November 1914) the frontline lay some 3 kilometres to the east of Bellewaarde, on the eastern side of the Geluveld Plateau. On 22 November 1914 the war of movement came to an end. Both parties took stock of their positions, dug in and waited for the spring to continue their efforts. The Second Battle of Ypres, starting on 22 April 1915, saw the first use of chlorine gas in history and ended with the Battle of Bellewaarde Ridge on 24 and 25 May, when gas again was used (De Vos et al. 2014: 226). Here the Germans pushed the Allies back to an inferior, low-lying position on the western side of the Geluveld Plateau ([Figures 2.1](#) and [2.2](#)).



2.1 Digital elevation model of the Geluvelde Plateau and the frontlines after the First and Second Battles of Ypres. © authors and source AGIV



2.2 View on Bellewaarde Ridge. Such higher ground was difficult to overcome for the Allied troops. © O. Pauwels

Bellewaarde, which is situated 4 kilometres to the east of Ypres, next to the Menin-Ypres road, had strategic value due to its elevation of more than 40 m. Like so many other elevated, and therefore strategic, places in the landscape (such as Hill 60, The Bluff and The Mound (Sint-Elooi)), Bellewaarde Ridge was the scene of fierce fighting and an intense subsurface tunnelling war.

This chapter focuses on Bellewaarde as an example of fighting to occupy and control higher ground, and then the struggles to keep such features at all cost. Since many traces of war are still visible at Bellewaarde, an integrated approach combining historical aerial photography, maps, geophysical prospection and trial trenching offered an opportunity to test a holistic approach in this contested landscape and understand its history, heritage values and archaeological preservation.

Archaeological Inventory and Trial Trenching

In 2010–11 the Flemish Heritage Agency compiled a comprehensive inventory of the World War I heritage in Flanders. This was concerned with the built heritage and the changing landscape; the entire area of Flanders was surveyed to that effect. To research the archaeological preservation of the buried heritage, a number of carefully chosen locations were evaluated with trial trenches (Verboven 2012: 42–61). There are obviously many different scenarios and post-depositional processes that could have influenced the state of preservation of war features. Heavy artillery shelling could have caused serious destruction of the war infrastructure, while some features may only have been in use for a very short time. Further, after the war extensive efforts were made to restore the land for agriculture, possibly destroying large parts of the conflict landscape. Later on, when scrap metal prices rose, renewed digging in some front zones was done – this scavenging could be very thorough, and erased many war traces. As there is no overview of the areas where this was done and to what extent, fieldwork is needed to establish with certainty the impact of these factors.

Archaeological trial trenching aimed to examine the archaeological imprint of the war, and addresses a series of research questions. Are any material remains or other traces still present? What is the nature of their appearance? Could these structures be considered valid archaeological heritage sites? Is there a difference in preservation between different landscape contexts?

As there is a need to create an overall picture of the archaeological heritage, the shifting positions of the frontlines at different stages of the war were taken into account. In total 32 trial trenches were set out at 18 locations along the Western Front in Flanders. This drew on information from aerial photographs (Stichelbaut 2011), along with the field knowledge of local farmers and war enthusiasts, who have built up a profound knowledge of the landscape. Besides the obvious battlefields where the fighting took place were other places of interest that were also selected; these included cemeteries, gun emplacements and training trenches (Verboven 2012).

Next to an Existing General Inventory

This work has generated a general overview of the area. Most visible remains of World War I are what we consider 'built heritage', such as pill boxes, military cemeteries and commemorative monuments. Very little of the original war infrastructure, with its thousands of kilometres of entrenchments and heavily shelled battlefields, have been preserved above ground. These landscape disturbances appear to have been wiped off the surface after the war. By reconstituting the landscape in the 1920s, entrenchments, shell holes, craters were filled in and covered by a thin layer of earth. Field boundaries and water management were restored, and returning inhabitants aimed to resume their pre-war life as much as possible. Before the war, the front area in Flanders was an intensively managed agricultural landscape. Thus, the need to restore the land was paramount, and most of the war infrastructure was dismantled, except for those features that were too big to fill in such as mine craters, and a few sites that were not redeveloped deliberately for post-war tourist or commemorative purposes. Although most traces of this immense military conflict have been thoroughly wiped out since 1918, the mine craters have often been preserved as a rare, peculiar landscape relic, still visible in the fields and in woodlands.

Besides Hill 60, Bellewaarde was one of the most explosive hot spots of the Ypres Salient. The area around Bellewaarde is a good example of the military operations during 'quiet' periods between offensives. A number of mine detonations, often followed by small skirmishes and local military actions, lead to small changes in the frontline.

Archaeological and Other Features

The Bellewaarde battlefield was examined in the winter of 2010 and spring of 2011, with the aim of contributing to a fuller understanding of both the landscape and other available sources.

Immediately after the capture of Bellewaarde Ridge on 25 May 1915 by the Germans the Allies planned a counter-attack. Between 7 and 12 June 1915 eight rows of concentration trenches were dug along Cambridge Road (Begijnbosstraat) and south of the Menin Road (Meenseweg) (see also Stichelbaut and Chielens 2013: 84). This allowed more than 3,000 soldiers to be brought to advanced positions. The attack was launched on 16 June and led to a minor gain of ground at the cost of more than 1,000 Allied casualties (Heyvaert 2006). On the German side there were more than 400 fatalities (Orgeldinger 1931: 98–107). The Liverpool Scottish Memorial commemorates the fallen of one of the regiments taking part in the action.

To examine the material remains of these actions, a trial trench was positioned to cut the frontline established after the Battle of Bellewaarde Ridge, along with some of the concentration trenches dug before the battle of

16 June and a communication trench (Dewilde and Wyffels 2014, Dewilde et al. 2014: 36–8, Stichelbaut and Chielens 2013: 84–5).

The excavations showed that the 1.4 metre deep frontline trench was only consolidated with a metal plate at the bottom. Since it was only in use for a short time, and knowing that it was dry at the time, presumably other measures were unnecessary. The concentration trenches were clearly intended to be temporary, taking the form of simple, relatively shallow ditches (1.15, 0.95 and 0.60 metres deep) without revetment. In contrast, the communication trench was very elaborate. Inverted A-frames of wood were put in the trench, keeping the duckboard walking platform 0.5 metres above the bottom of the trench and thus avoiding wet feet. The A-frames were strengthened with a metal strap and covered with corrugated iron on the front side. Within the excavated area the trench had clearly suffered a shell impact, as an A-frame is twisted (Figure 2.3). The aerial photographs show that this trench was developed after the fighting of June 1915.

It is clear that the appearance of the trenches relates to the purpose they served. In contrast with long-lasting trenches, temporary structures are not that elaborate. In this respect the season of construction and use can be of importance. Still, even the most short-lived structures can leave an archaeological imprint and are to be taken into account.

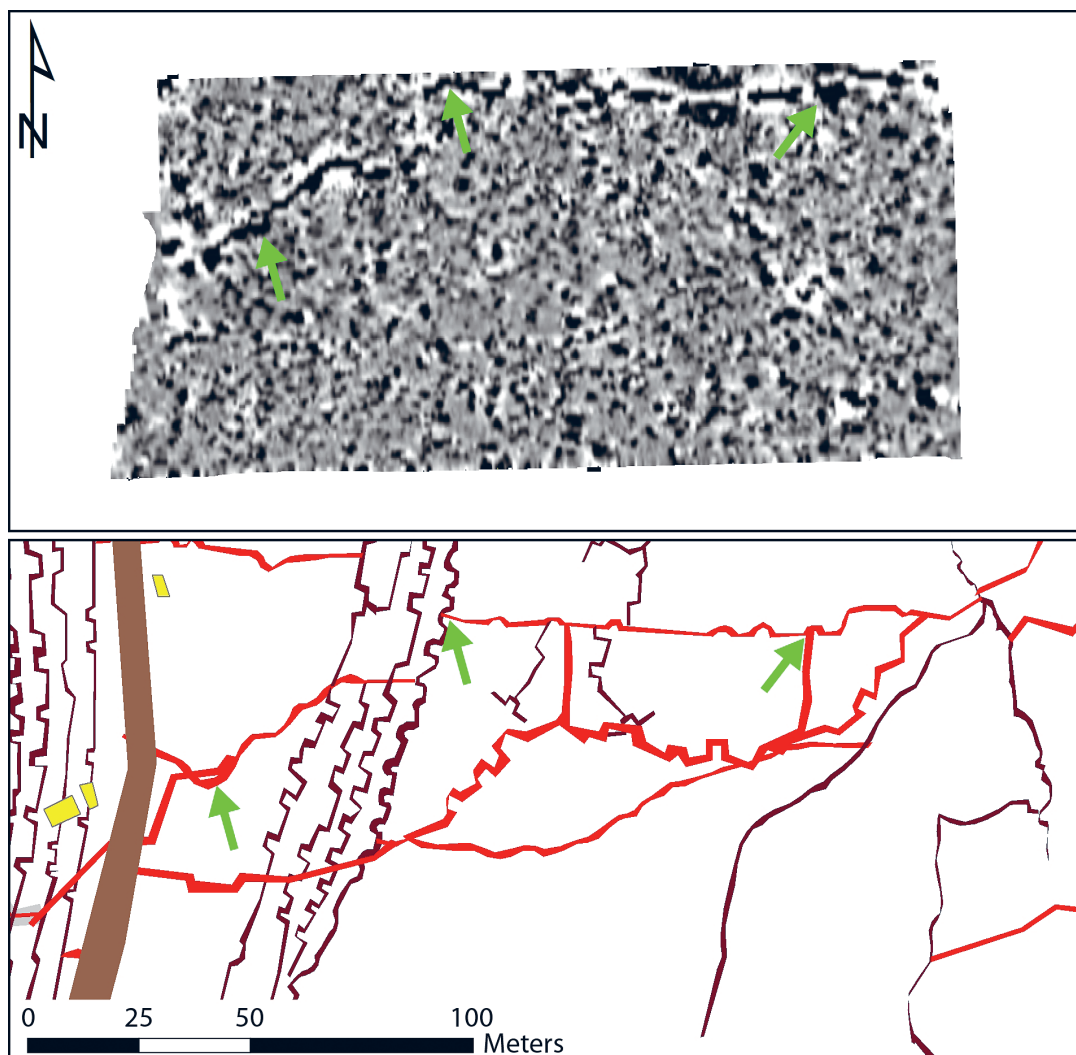
The area surrounding this trial excavation was also surveyed with a magnetometer (Masters 2012: 5, 12, Figs 18–20). However, the results were not straightforward and provided a blurry, confusing picture. This reflected the intensive shelling that left metal fragments all over the battlefield (Figure 2.4). The communication trench is clear as it contains a lot of metal, but the concentration trenches are not, probably because they contain no metal and were backfilled with the same silty material as the surroundings. The temporary frontline trench, despite having a metal plate at its base in places, is not convincingly evident in the geophysical survey data – perhaps because it was too deep to be detected. Many other possible features can be distinguished, and these need to be looked at in detail in combination with the aerial photographs in order to be interpreted.

Stalemate in the Trenches and Mine Warfare

After the attack of 16 June 1915 the frontline stagnated, and the stalemate in the trenches developed into a new phase of intense mine warfare (Verboven 2014: 8, 10–11). With the Germans occupying the higher ground the British tried to dislodge them by digging underground mines below their positions. For these purposes the low-lying British positions were an advantage, requiring less effort to dig mine galleries deep below the German trenches. Generally, the detonation of the mines was followed by infantry attacks aiming to capture the newly formed crater and establish a more favourable position *vis-à-vis* the



2.3 Section of the communication trench, showing a clearly twisted A-frame. © F. Wyffels



enemy lines. Because of its strategic position, Bellewaarde Ridge was one of the most contested places in this respect.

The first British mine in this front sector exploded at Hooge on 19 July 1915, a kilometre southeast of Bellewaarde Ridge. The attack allowed the Allies to advance to a higher, much more favourable position (Verboven 2014: 11). This was the start of a period of an intense siege war. It was, however, a short-lived advance, as the Germans recaptured the crater on 31 July, using flamethrowers for the first time (Heyvaert 2006: 32, De Vos et al. 2014: 227). At Bellewaarde Ridge the first British mine exploded on 25 September 1915, near Railway Wood, where the Allies nearly reached the German positions. This location was chosen by the British to launch an attack on the German front in order to pin troops and divert German attention from a bigger offensive at Loos in the north of France (Heyvaert 2006: 31–8). The mine explosion was

2.4 Geophysical survey (P. Masters), compared to the information mapped from several aerial photographs. © GIS data B. Stichelbaut; geophysical survey P. Masters

followed by small-scale attack that eventually turned into a disastrous British failure. The attacking forces reached the enemy lines but were mowed down by German machine-gun fire. They had to retreat into the crater but could not hold position. The attack died away in just two days without any advance at all (Reinhardt 1924: 31–3).

The first German counter-mine detonated on 17 October 1915 (Dewilde et al. 2014: 35) as a reprisal for the September attack (Reinhardt 1924: 35, Barton et al. 2005: 119). This heralded a series of mine explosions in the area with alternating British and German counter-mines (Orgeldinger 1931: 136, Reinhardt 1924: 35). In 1915 further mines were detonated on 19 and 24 November and 14 December 1915. Bellewaarde is one of the few places in the Ypres Salient where an underground war continued for almost two years, most intensively in 1917 (Dewilde et al. 2014: 34, Tiessen 1937: 470).

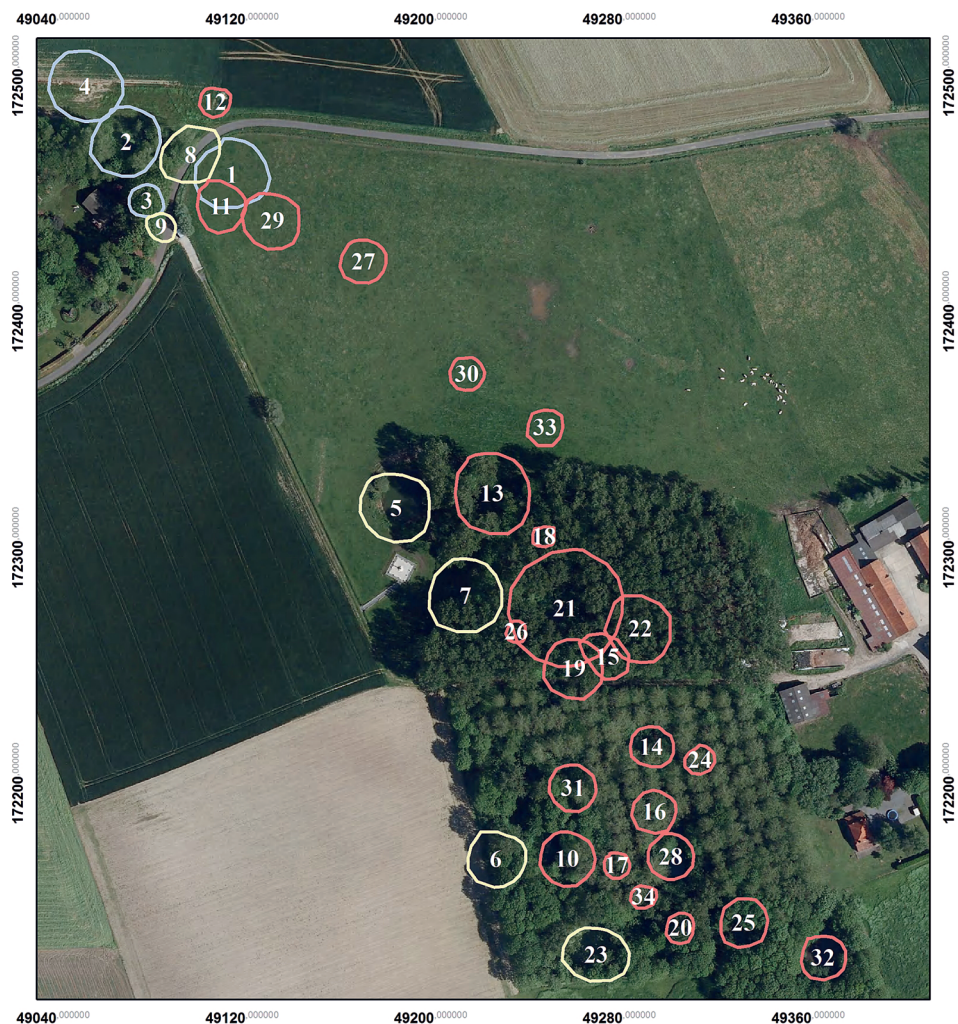
The mine warfare in this area saw in total 34 explosions (Figures 2.5 and 2.6), mostly in no man's land, as can be seen from an aerial photographic study (Dewilde et al. 2014: 34) with additional information from trench maps and mine reports of the 177th Tunnelling Company of the Royal Engineers. Aerial photographic research indicated that the last mine was detonated between 24 and 27 July 1917, just a few days before the launch of the Third Battle of Ypres.

In the beginning the mines were shallow, lying some 5 to 6 metres below the surface, though later depths of 10 to 12 metres were reached (Verboven 2014: 20). The remorseless underground war caused many casualties on the surface, and some underground. At the north-western edge of Bellewaarde Wood a cross of sacrifice and 12 small limestone posts commemorate the death of 12 men of the 177th Tunnelling Company, killed in collapsed tunnels below the surface.

The remains of this warfare are still visible on the Bellewaarde Ridge as large, circular depressions, sometimes filled with water, in the pasture next to Bellewaarde Farm and in Bellewaarde Wood. Twelve craters are extremely well preserved in a small patch of woodland, which was planted after the war because it would be too much effort to reclaim it for agriculture. It has since been used as a hunting reserve.

The uneven surface topography of the pasture next to Bellewaarde Farm clearly shows the scars of war and relate to buried traces of trenches, shelters and mine-craters, or point to collapsed underground galleries. Indeed, in 2000 a major sagging of the ground surface occurred less than 100 m from the Liverpool Scottish Memorial. It was superficially investigated by the Diggers, an association of amateur archaeologists. Their research hinted at the collapse of a deep tunnel below the surface (Van Wanzeele 2001: 18). This is one example of numerous incidents that still occur in the Ypres Salient and clearly are related to the underground war.

Besides Bellewaarde at least 17 other sites on the front in Belgium deployed mining schemes. The underground war developed where no man's land was narrow, and where differences in altitude played a role and where the enemy had constructed strategic bulwarks. Mine warfare escalated at the Messines Ridge, where the war went deeper underground, using even more powerful



○ 1915
 ○ 1916
 ○ 1917

Orthofoto: GDI - Vlaanderen

- | | | |
|--------------------------------|--------------------------------|---|
| 1: 25/09/1915 | 13: 9/03/1917 (Blakely Crater) | 23: tussen 26/04/1916 - 10/05/1916 (N°1A) |
| 2: 17/10/1915 (N°3) | 14: 28/03/1917 (James Crater) | 24: tussen 4/04/1917 - 13/05/1917 (N°10) |
| 3: 10/12/1915 | 15: 9/04/1917 (New Cotter) | 25: tussen 4/04/1917 - 13/05/1917 |
| 4: 15/12/1915 (N°4) | 16: 10/04/1917 (N°9) | 26: tussen 4/04/1917 - 13/05/1917 |
| 5: 14/02/1916 (N°2) | 17: 5/05/1917 | 27: tussen 4/04/1917 - 13/05/1917 |
| 6: 14/02/1916 (N°1) | 18: 5/05/1917 | 28: tussen 4/04/1917 - 13/05/1917 |
| 7: 3/05/1916 (N°2A) | 19: 9/05/1917 (N°12) | 29: tussen 4/04/1917 - 13/05/1917 |
| 8: 12/06/1916 | 20: 12/05/1917 | 30: tussen 24/05/1917 - 15/06/1917 |
| 9: 24/11/1916 | 21: 29/05/1917 (Momber Crater) | 31: tussen 24/05/1917 - 15/06/1917 |
| 10: 3/02/1917 (Hornby Crater) | 22: 4/03/1917 (Old Cotter) | 32: tussen 24/05/1917 - 15/06/1917 |
| 11: 25/02/1917 (Gordon Crater) | | 33: tussen 24/07/1917 - 27/07/1917 |
| 12: 1/03/1917 (Buckley Crater) | | 34: tussen 4/04/1917 - 13/05/1917 |

2.5 Overview of the craters at Bellewaarde and Railway Wood.

© GIS data B. Stichelbaut; AGIV: orthophoto source



2.6 Ullrich, a German mine, under the British first line, exploded on 14 February 1916.
© O. Pauwels

blasts and further developing techniques for the construction of shafts and tunnels through geological layers formerly considered impenetrable. However, none of these changes characterises the underground war in Bellewaarde. Probably because of its different geological and geographical situation east of Ypres, the site was not incorporated in the general plan of deep mines at the Messines Ridge, another sector of the front in Flanders. Miners kept on digging at a limited depth below surface. However, one big crater caused by an explosion on 29 May 1917 might suggest a shift towards the use of more powerful charges or deeper shafts and tunnelling systems. Compared to other preserved mine crater sites Bellewaarde contains the most well preserved set of 12 craters that makes this site unique.

Archaeology at Bellewaarde

In the Bellewaarde pasture another two trial excavations were conducted (Dewilde and Wyffels 2014, Dewilde et al. 2014: 36–9), again mainly guided by the aerial photographic information (Stichelbaut and Chielens 2013: 76–7, 84–5, 120–21, 338–9). Several deep trenches were revealed at the Allied frontline. These are not substantially developed, probably because they were continuously under fire, needing to be repeatedly repaired. The fire-trench comprises a U-shaped ditch, some 0.7 to 1.0 metres across at its base and up to 1.5 metre in depth, with side walls of corrugated iron and



wooden posts and planks at the bottom. There are clear indications of destruction, such as the deformation of a corrugated iron wall (Figure 2.7). It also seems, on the basis of the few finds, that these positions were rarely manned, perhaps only used to mount guard because of the danger of explosions.

The other trial trench aimed to explore the German lines, which lay on a former Allied trench which was repurposed by German troops after they captured it. Initially, the trench faced east, with traverses pointing west towards the 1915 German positions. After capturing the trench the Germans 'turned' it, so that it could be used against any attack from the west. In addition, shelters were dug and the trench was incorporated into the German trench network by means of new communication trenches. The excavations revealed several features connected to this episode. Around a concrete shelter (approximately 4.5 to 6.0 metres) and an adjacent communication trench traces of extensive sandbagging were observed. As expected, the frontline trench was clearly present, with the excavation showing that it had been repaired on different occasions. The walking level was heightened, effectively providing drainage for the trench. At the bottom traces of wickerwork (Figure 2.8) clearly illustrated the form of revetment for the walls of the trench. This trench gave access to a shelter (2.4 to 1.8 metres) built from prefabricated planks, round timbers and cross-pieces, marked with Roman numerals to facilitate assembly. Again it was protected from enemy fire by sandbags (Figure 2.9), a layout that is visible on an aerial photograph taken in August 1915.

The former Allied trench was clearly situated on the most favourable location for the Germans, so they could exploit it with only minor adaptations.

2.7 Section of an Allied frontline trench at Bellewaarde.
© F. Wyffels



2.8 Detail of the German trench, showing remains of the wickerwork. © F. Wyffels



Since further progress was not achieved, this was the frontline for more than two years.

The geophysical survey of the Bellewaarde pasture (Masters 2012: 5, 11–12, Figs 13–17), again predominately in no man's land, clearly illustrates the effects of heavy shelling. The German frontline and shelters are visible, though the Allied lines are less clear. Other expected lines, such as communication trenches, are not that distinct. In some of the craters modifications for possible use as strong points can be faintly observed. Other features are less easy to interpret and demand further investigation.

2.9 German shelter, connected to a trench. In the section traces of sandbagging can be seen.

© F. Wyffels

A Turning Point in 1917 ... and in 1918

The Third Battle of Ypres, starting on 31 July 1917, dramatically changed the situation, as at first the Allies quickly overran the Germans. However, the intended goals were not reached and the attack was stopped at Passendale on 10 November, some 9 kilometres from the starting point. This effort was eventually in vain, as in the spring of 1918 the Germans retaliated, overrunning Bellewaarde Ridge in an attempt to make a final breakthrough. Ultimately

they met with disaster. Finally, in August 1918 the Allied offensive that was to end the war was launched.

Conclusion

The study of Bellewaarde shows the added value of integrated approaches which contribute to greater knowledge and understanding of this section of the front. While the Bellewaarde landscape of mine craters and rough, uneven terrain speaks of the fierce fighting and the historical facts are common knowledge, the archaeological excavations, guided by aerial photographic interpretation and enhanced by geophysical survey, allow a fuller appreciation of this landscape.

Bellewaarde is an authentic *lieu de mémoire*, a memorial and commemorative site. It is a historically meaningful place, where the remains of the war landscape are clearly present and can be visually experienced in a coherent way. It is thus a place that should be protected from development in order to preserve it as a 'readable' war landscape for generations to come (Verboven 2012: 72–7).

All this must contribute to a better understanding and management of World War I heritage in general. One of the options to be explored is the idea of integration of World War I heritage sites into environmental planning. When a local or regional authority draws up an environmental implementation plan, they should take into account the present heritage values and anchor them forever.

References

- Barton, P., P. Doyle and J. Vandewalle (2005) *Beneath Flanders Fields: The Tunnellers' War 1914–1918*. Montreal: McGill-Queen's University Press.
- De Vos, L., T. Simoens, D. Warnier and F. Bostyn (2014) *14–18 Oorlog in België*. Leuven: Davidsfonds.
- Dewilde, M. and F. Wyffels (2014) *Proefsleuvenonderzoek bij Bellewaarde Hoeve en Y Wood (Zillebeke-Ypres). De sporen van de 'Grote' Oorlog archeologisch onderzocht*. Unpublished report. Brussels: Agentschap Onroerend Erfgoed.
- Dewilde, M., B. Stichelbaut, Y. Van Hollebeke, H. Verboven and F. Wyffels (2014) Bellewaarde en zijn turbulente oorlogsverleden. *M&L: Monumenten, Landschappen en Archeologie* 33(3): 30–47.
- Heyvaert, B. (2006) Van het westelijk front geen nieuws? (juni 1915–juni 1917). In P. Chielens, D. Dendooven and H. Decoodt (eds) *De laatste getuige. Het landschap van Wereldoorlog 1 in Vlaanderen*, pp. 31–8. Tielt: Lannoo.
- Masters, P. (2012) *Archaeological and Landscape Survey of Flanders Fields: Geophysical Survey of WW1*. Unpublished Cranfield Forensic Institute Report No. 54. Cranfield: Cranfield University.

- Orgeldinger, L. (1931) *Das Württembergische Reserve-Infanterie-Regiment Nr. 246*. Stuttgart: Belser A.G.
- Reinhardt, E. (1924) *Das Württembergische Reserve-Infanterie-Regiment Nr. 248 im Weltkrieg 1914–1919*. Stuttgart: Belser A.G.
- Stichelbaut, B. (2011) The First Thirty Kilometers of the Western Front 1914–1918: An Aerial Archaeological Approach with Historical Remote Sensing Data. *Journal of Archaeological Prospection* 18(1): 57–66.
- Stichelbaut, B. and P. Chielens (2013) *De oorlog vanuit de lucht 1914–1918. Het front in België*. Brussels: Mercatorfonds.
- Tiessen, M. (1937) *Königlich Preussisches Reserve Infanterie Regiment 213. Geschichte eines Flandernregiments*. Glückstadt: Studienrat.
- Van Wanzele, P. (2001) Diggers, juli, augustus, september 2000. *Historia Flandrensis* 9(1): 14–20.
- Verboven, H. (ed.) (2012) *Syntheserapport over de aanpak, methodiek, resultaten en aanbevelingen van het WO I erfgoed*. Unpublished report. Brussels: Agentschap Onroerend Erfgoed.
- (2014) De Westhoek ondermijnd. *M&L: Monumenten, Landschappen en Archeologie* 33(1): 6–27.



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Contested Landscape: La Boisselle and the Glory Hole

Peter Masters

Abstract

The village of La Boisselle on the Somme was the scene of intense fighting during World War I, but until 2011 the former battlefield remained largely untouched. La Boisselle is known for its underground battlefield of deep tunnels and mineshafts extending over several kilometres beneath the village, while above ground the area is littered with mine craters. The La Boisselle Study Group started archaeological investigations including geophysical research in 2011, undertaken to locate potential ordnance contamination. The aerial photographs that were taken along this sector of the Western Front correlate with some of the results from geophysical survey. In 2013 a programme of geophysical survey by Cranfield University aimed to record what still survives by applying different techniques. This chapter will show some of the results to date as well as highlighting some of the problems of undertaking geophysical surveys in a contested landscape such as one that saw intensive fighting from 1914 to 1916.

Keywords: La Boisselle, magnetometry, World War I, battlefield, geophysical survey, Somme.

Introduction

La Boisselle was a heavily fought over battlefield during World War I. The area was not just contested above the ground, but also below the surface, where a tunnel system under the village of La Boisselle covered an area of 1 kilometre × 0.4 kilometre in extent, to a depth of up to about 34 m. Geophysical techniques were first used by BACTEC (Battle Area Clearance, Training, Equipment and Consultancy) for unexploded ordnance (UXO) clearance (see also [Chapter 12](#)), but their survey also showed some of the trenches. However, the ground

surveyed was limited to the area of excavation undertaken by the La Boisselle Study Group (Byledbal et al. 2012).

The La Boisselle Study Group began their investigations of a military mine system in La Boisselle village in September 2011. During the war the British called this the 'Glory Hole' and the name refers to the surface depressions or craters produced by the underground mining. These features can be seen today around some of the houses of the village. The frontline trenches were less than 50 m apart here, and small mines were detonated by both sides in order to try to gain some advantage. The aims and objectives of the study group were based on the exploratory *sondages* dug in 2011 in order to continue the excavation of the entrance to the tunnel X Incline, the entrance to the tunnel of the W Adit, the Quemart trench and the farm buildings.

In July 2013, a geophysical survey (Masters 2014) was carried out at La Boisselle using magnetometry and Ground Penetrating Radar (GPR). The area was heavily cratered to the northeast limiting the survey to the eastern and southern areas where the ground had not been excavated or showed any earthwork traces of battlefield remains above ground.

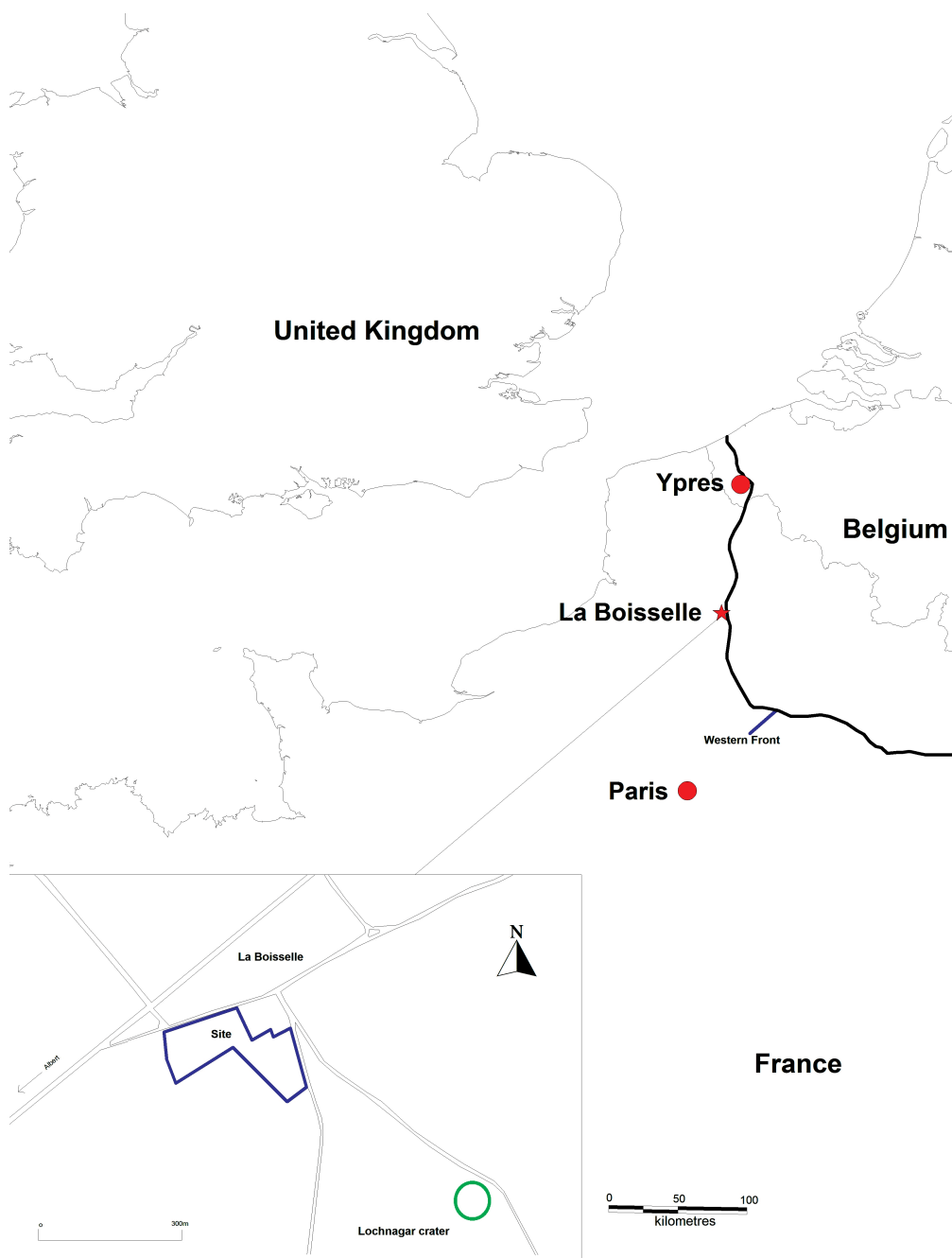
Previous geophysical surveys, undertaken in Belgium and of practice trenches in the UK, have produced some exceptional results in detecting buried trenches and related features (Masters 2007, Masters 2008, Masters and Stichelbaut 2009). More recently, electromagnetic induction (EMI) has been used on 3.2 hectares of land close to Mount Kemmel (Saey et al. 2013), demonstrating that it is a useful tool in the investigation of former battlefields (see also [Chapter 1](#)).

The aims of the survey project at La Boisselle were to apply the same techniques used elsewhere to determine the responses from a heavily contested sector of the Western Front. In addition, the survey aims to assess whether the ground would be too magnetically disturbed to obtain clear results and how effective would GPR be on this type of geology compared to the clay geology in Belgium.

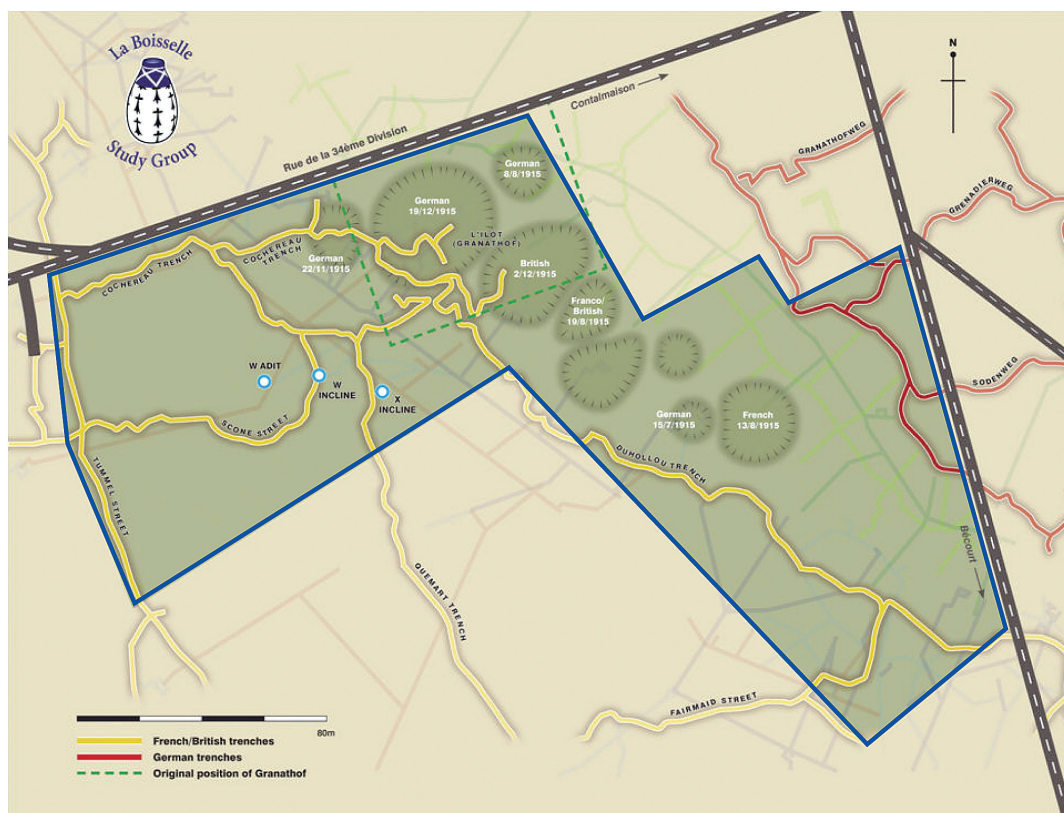
Location

The village of La Boisselle is situated on the Bapaume to Amiens road (D929), 4 kilometres northeast of Albert and 15 kilometres to the southwest of Bapaume ([Figure 3.1](#)), on the flank of a hill overlooking an outcrop of limestone over the Ancre Valley. This rolling landscape was occupied by both sides, although the Germans held the more favourable tactical positions with Mash Valley to the north and Sausage Valley to the south.

Close to the southeast of the site is one of the largest and most well known mine craters on the Somme battlefield, Lochnagar crater, which is situated about 500 metres from the area of investigation ([Figure 3.2](#)). This was packed with 27,000 kg (60,000 lbs) of explosives at a depth of about 16 metres (52 feet) (Barton 2011: 142, Doyle 1998: 69) and was detonated on 1 July 1916.



3.1 Location map and inset of site showing outline of survey area. © author



3.2 Detailed map of site showing outline of survey area in blue and the positions of the trenches. © La Boisselle Study Group and reproduced with their kind permission

The underlying geology of this area is solid chalk overlain by a thin layer of Somme clay. In areas of chalk geology, features of geomorphological origin may sometimes be recorded in magnetic and GPR surveys, especially where it is quite variable. This is discussed in the geophysical survey section below.

In January 2011, the La Boisselle Study Group started a long-term investigation of this unique piece of World War I battlefield, which has been little disturbed since 1918. In advance of the excavations BACTEC carried out a magnetometry survey in July 2011 to assess the presence of UXO (Byledbal et al. 2012: 23). After two seasons of excavation, 250 square metres have been uncovered revealing the remains of the farmhouse, trenches and the X and Y inclines.

Historical Background

In September 1914 the advancing German Army was halted here by the French, and bitter fighting took place to gain possession of the civilian cemetery and the farm buildings on the south-western edge of the village known to the Germans as Granathof ('Shell Farm') and by the French as Ilôt (the 'Islet') (Whitehead 2009, Byledbal et al. 2012).

In December 1914, French engineers began tunnelling beneath the ruins, which started a prolonged struggle below ground that expanded and deepened on a daily basis until July 1916 (Byledbal et al. 2012: 19). At this time, stalemate had been reached and both sides probed beneath the opponent's trenches, detonating explosive charges of ever-increasing size. In August 1915, the British took over at the Somme and by this time the French and German tunnels had reached a working depth of about 12 m. Explosive charges had reached 3,000 kg, and no man's land was already a line of mine craters (Byledbal et al. 2012: 16).

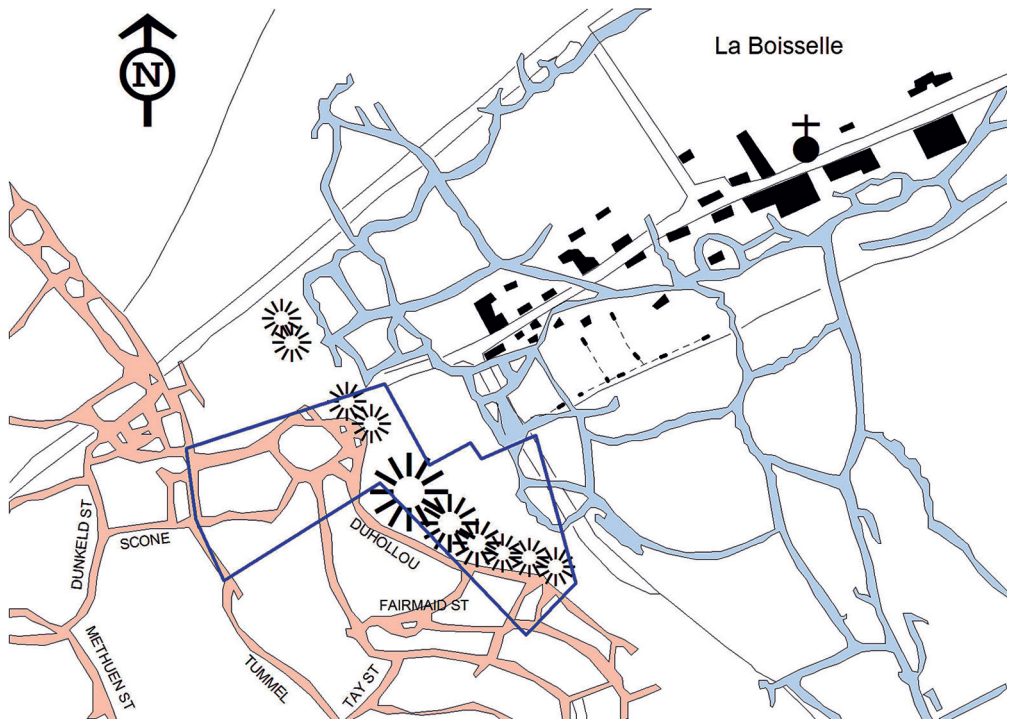
The underground warfare was further extended with the deployment of British Tunnelling Companies and the system was first extended to 24 metres and then to 30 metres depth. By December 1915 explosive charges of up to 8,000 kg had been detonated by British tunnellers, and 33,000 kg by their German opponents. Today, many of the miners' bodies still lie deep beneath the crater fields. Above ground the frontline trenches were in places only about 45 metres apart and the infantry lived in constant danger of snipers, mortar bombs, grenades and enemy mines beneath.

At the beginning of the Battle of the Somme, La Boisselle stood on the axis of the British offensive. The ruined houses were heavily fortified by the Germans, while the deeply-cratered ground of the 'Glory Hole' made direct assault on the village impossible. The British therefore placed two massive mines known as Y Sap and Lochnagar on either flank. Even these massive mines failed to destroy the German defences. On 1 July, the 34th Division suffered heavy losses but on 4 July La Boisselle was finally captured.

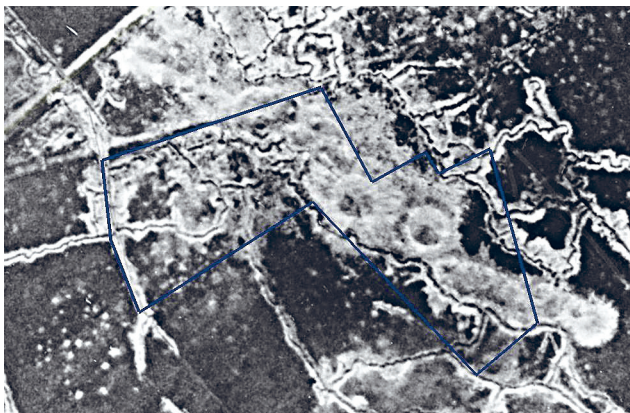
AERIAL PHOTOGRAPHS AND TRENCH MAPS

With the ever-changing landscape around La Boisselle, trench maps were sketched in the early years of the conflict here (Figure 3.3). However, despite the inaccuracies of the initial freehand sketched trench maps, some correlation with the geophysical survey results are quite evident (see below), especially Dohollou trench and the German frontline trenches.

A considerable number of aerial photographs were taken in this sub-sector of the Western Front. Thousands of photographs of this sector can be consulted in the Imperial War Museum's Box Collection of World War I aerial photographs. Some were also taken from observation kite-balloons some distance to the rear of the frontline action. The aerial photographic coverage (Figure 3.4) clearly shows the dark shadows of the deep trenches amongst the chalk upcast in between the faint mine craters. The German frontline was subjected to such continuous artillery fire that it appears on aerial photographs taken between 1915 and July 1916 as a blurred line. The blurring is caused by the number of mine craters that were exploded on both sides (Barton 2011: 137).



3.3 La Boisselle and the Glory Hole, a British trench map dated November 1915.
© author (based on WO95/2033 National Archives)



3.4 Aerial photograph of the site showing the landscape in August 1915 with the site outlined in blue.
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GEOPHYSICAL SURVEY

Two geophysical survey techniques were employed to survey this battlefield and explore the nature and preservation of the buried war heritage: gradiometry and Ground Penetrating Radar (GPR). Resistivity survey was not undertaken at the time due to the dry ground conditions. Gradiometry was undertaken using a Bartington Grad 601-2 fluxgate gradiometer (Bartington and Chapman 2004), with readings taken at 0.25 metre intervals along transects at 1 metre spacing. The zigzag traverse method of survey was used, with 1 metre wide traverses across 20 × 20 metre grids. The sensitivity of the machine was set to detect magnetic variation in the order of 0.1 nanoTesla and the data was processed using TerraSurveyor v.3. The ground penetrating radar survey employed a Malå Geoscience AB RAMAC/GPR system consisting of shielded monostatic 500 MHz antenna, CUII control unit and XV monitor to collect profiles. Individual profiles were collected over the site at a station spacing of 0.05 metres. Post-acquisition data processing was carried out using RAMAC GroundVision 1.4.6 and Reflex 3Dscan software. DC offset and automatic gain corrections were applied to the radar data to correct for low frequency noise and amplitude attenuation with distance respectively (Conyers 2004: 119–31).

Results

The survey results varied considerably from no responses whatsoever to where the ground was magnetically very noisy making interpretation of the morphology of the anomalies difficult. This is in contrast to previous surveys of battlefields and trenches recorded at Plugstreet (Comines-Warneton, Belgium) (Masters and Stichelbaut 2009) and at Perham Down on Salisbury Plain (UK) (Masters 2007). Five separate areas were surveyed across the La Boisselle site (Figure 3.5). Area 2 gave the best results overall for both magnetometry and GPR.

GRADIOMETER SURVEY

Area 1 covered an area approximately 0.4 hectares. A curvilinear positive magnetic anomaly (Figure 3.5, A) represents Scone Street trench. Two further curvilinear anomalies (Figure 3.5, B) were recorded a short distance to the east. It is not possible to say what trenches these are as they are outside and west of the trench that originally ran within the farm courtyard which was designated as Îlot trench. Two strong square anomalies (Figure 3.5, C) are possible dugouts or mineshafts. These are joined by two linear anomalies that may indicate the presence of trenches adjoining the dugouts or mineshaft entrances. The GPR survey confirmed the anomalies detected by magnetometry (not illustrated).

Area 2 was located to the southeast of the archaeological excavation area and is currently in agricultural use as a hay meadow covering about 1 hectare. The ground in this field is uneven where trenches have been partially backfilled. This field is also surrounded by mine craters in between the German and Allied frontline.



3.5 Magnetometer survey results (top) and interpretation of magnetometer survey results. Letters on the interpretation relate to anomalies discussed in text. © author

The most distinct responses from the gradiometer survey are the Allied frontline Dohollou (D) and the German frontline (E) trenches in Area 2. This area, the largest of the surveyed blocks, also produced large dipolar magnetic signatures relating to mine craters. Most of these have been backfilled since 1918 although humps, bumps and hollows are still evident in this field. The aerial photographic coverage (Figure 3.4) depicts these trenches very clearly with the chalk upcasts forming parapets which delineate them.

Immediately adjacent to Dohollou trench, two highly magnetic square shaped anomalies are clearly shown (Figure 3.5, F) possibly indicating dugouts or mineshafts. Across the central part of the field four large amorphous highly magnetic zones are clearly shown (Figure 3.5, G). These are likely to be partially infilled mine craters. The magnetic signature may also indicate the presence of structures such as concrete bunkers/shelters. The GPR profiles recorded in this area confirmed the anomalies detected by magnetometer (see Figures 3.6 and 3.7).

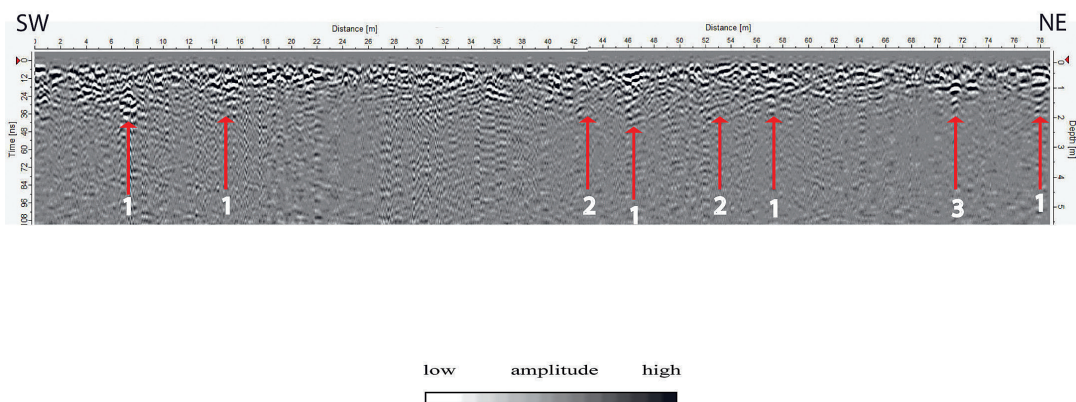
At the northern end of the field a curvilinear shaped anomaly (Figure 3.5, H) was detected close to the field boundary, probably denoting the presence of a communication trench. Two further short curvilinear anomalies (Figure 3.5, J) at the northern end of the survey area possibly indicate the presence of trenches.

Area 4 covered 20 metres × 40 metres, within which two negative curvilinear anomalies (Figure 3.5, K) were detected, possibly representing trenches. The one closest to the fence was known as Cochereau Street whilst the other may denote a redoubt or rear trench. Area 5, situated to the west of the W Adit (an incline that affords the easiest access to an underground chamber), houses the vertical shaft 'W Shaft' (Byledbal et al. 2012: 24) which is about 15 metres deep. Although the magnetic responses in this area were extremely poor, an ephemeral curvilinear anomaly was recorded (Figure 3.5, L) along the western edge of the survey area, possibly the Tummel Street trench.

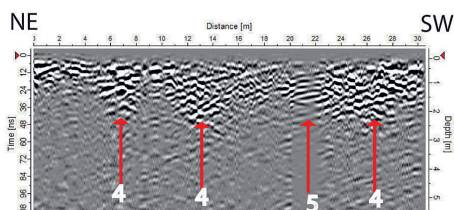
GROUND PENETRATING RADAR

Ground Penetrating Radar (GPR) added a new dimension to the magnetic survey results in showing depth and dimension of features, in particular along profiles 13, 14 and 17, demonstrating its usefulness here. Profile 13 extended from the Dohollou trench to the German frontline trench, and clearly shows the trench outlines as high-amplitude reflections (Figure 3.6, 1) varying in depth from 1.5 metres to 2.5 metres. Two hyperbolic reflections at a depth of about 1.5 metres at 43 metres and 53 metres along the profile respectively (Figure 3.6, 2) indicate voids that may represent shallow craters (not clear in the magnetometer survey). Metal reflections are also represented, though not as noisy as would be recorded by magnetometer as can be seen at 72 metres along profile 13 (Figure 3.6, 3) and about 70 centimetres below the present surface. The whole area is strewn with metal remains and therefore such reflections are not surprising. Profile 14 was positioned in the northern part of Area 2 and close to the German frontline.

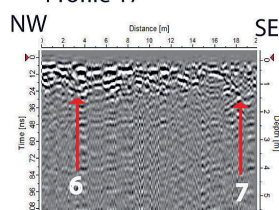
Profile 13



Profile 14



Profile 17



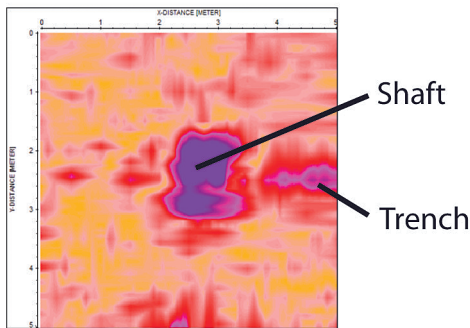
3.6 GPR profiles 13, 14 and 17. Numbers on the interpretation relate to anomalies discussed in text.
© author

Three broad reflections were recorded (Figure 3.6, 4) to depths of around 3 metres. These denote partially infilled mine craters, which are partly visible on the ground today as slight depressions. Between 20 metres and 22 metres along the profile a high-amplitude reflection was recorded (Figure 3.6, 5) that probably indicates the presence of concrete considering there are limited reflections below this. It is likely either to represent remnants of concrete from explosions or could be part of a bunker.

Within Area 2 a gridded area measuring 5 metres × 5 metres was placed over a potential mineshaft. This area was chosen due to an existing 1 metre square shallow depression believed to be caused by a tunnel entrance. At the centre of the horizontal slice, a square, high-amplitude reflection was recorded (Figure 3.7) denoting the presence of a possible mineshaft with reflections recorded to a depth of about 4.5 metres. To one side, a short, linear, high-amplitude reflection (Figure 3.7) is also clearly shown indicating the remains of a possible trench. The magnetometer survey recorded the presence of the shaft (Figure 3.5, F). The location of this shaft is not visible on aerial photographs and may have been camouflaged.

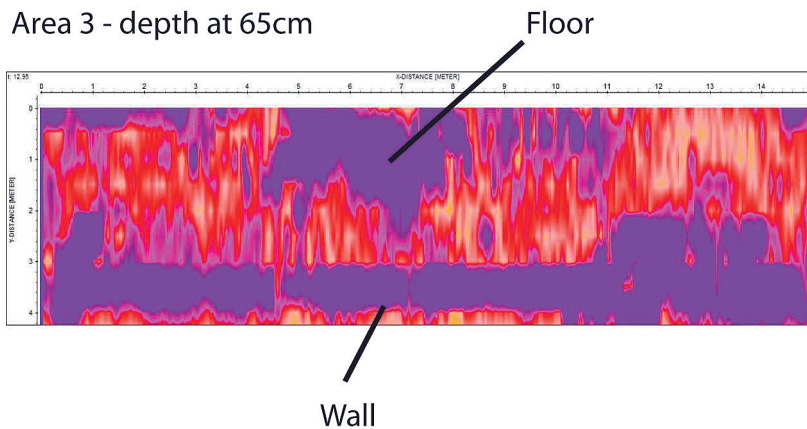
Area 3 was located beside the Quemart trench and the farm courtyard. Only GPR was used in this area due to the limited remaining space following excavation over the past two seasons. The purpose of the survey here was to locate any remains of the farm buildings and to locate the X Incline gallery

Area 2 - depth at 35cm



3.7 GPR horizontal time slices of Areas 2 and 3. © author

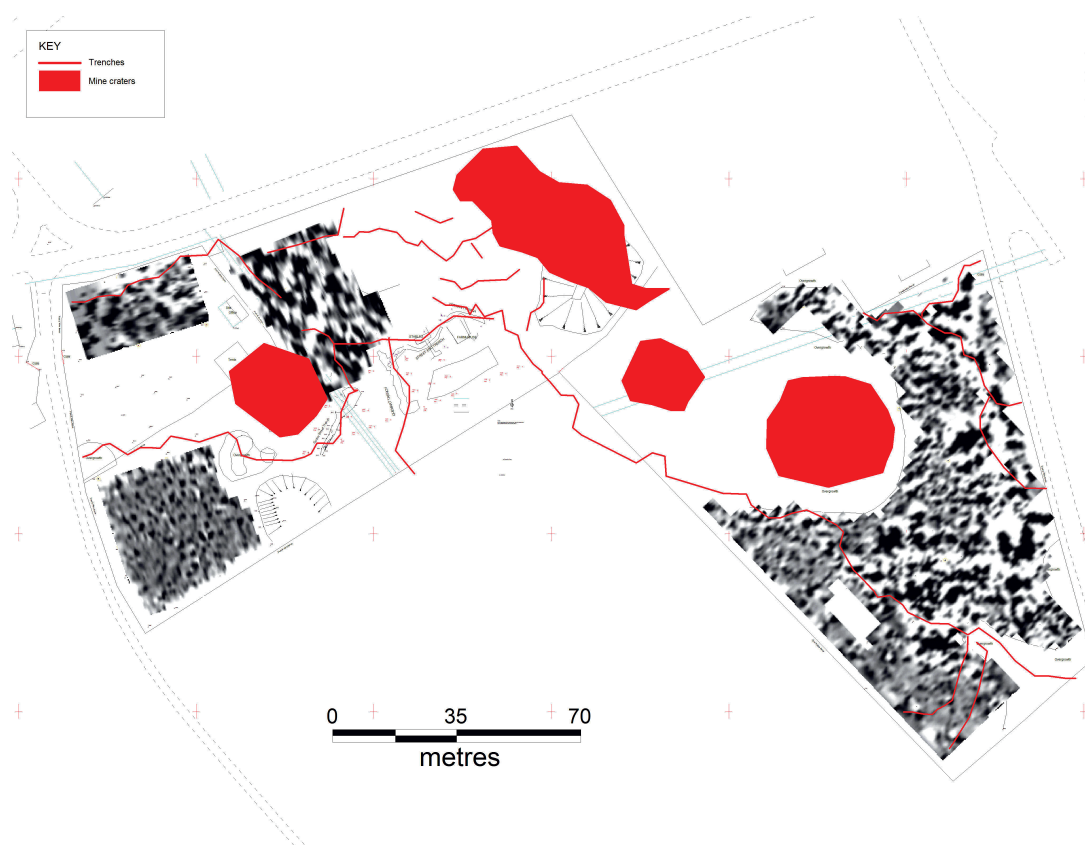
Area 3 - depth at 65cm



beneath the building. A linear, high-amplitude reflection in the horizontal time slices at a depth of between 0.45 metres and 0.65 metres (Figure 3.7) probably represents the remains of one of the walls of the farm buildings along with possible remains of a floor surface (Figure 3.7).

No reflections of the X Incline were detected and it does not appear to be present in the profiles or in the 3D imaging. Explanation for this is rather complex considering other features such as shafts and craters to a depth of about 5 metres were quite evident in the radar profiles. One reason could be that the farm had suffered a large impact explosion and that the underlying sequence of layers may have masked it, or it may be due to the geological strata formation in this area that has had an effect on the radar. It is also probable that the antenna being used was not appropriate to the detection of deeper features.

The comparison of the aerial photographic interpretation with the geophysics (Figure 3.8) shows a good correlation. However, the magnetometer survey gives more detail than is shown in the aerial photographs due to the nature of the battleground at La Boisselle (Figure 3.4) where it is likely that some of the remains were camouflaged against aerial observation.



3.8 Combined gradiometer survey greyscale images with the aerial photographic interpretation in red. © author

Conclusions

The geophysical survey at La Boisselle shows the advantages of using combined techniques. The GPR survey results provided further detail at depth and demonstrated utility in recording buried trenches, mine craters and structures. However, the GPR survey failed to record the X Incline gallery and W Adit possibly due to the complex nature of the ground here.

Area 2 proved to be the most interesting as the results showed the best responses from both techniques. In addition, the trench maps and the aerial photographs provide a good correlation with the results obtained from the geophysical survey techniques. The reason the results proved to be successful may possibly lie in the fact that this field has not been touched since 1918 and has only been used as a hay meadow.

As previously stated, the area was heavily contested and the survey results show this. In places, especially Area 5, no responses were recorded, suggesting that the trenches here were not lined or reinforced, or they could have been used over a short period of time and then abandoned. Short-lived trenches tend to be more visible in the aerial photographic coverage and the early sketched trench maps than from geophysical techniques as they would not have been

lined with corrugated iron sheets. Future investigations of the Western Front should consider other techniques such as caesium magnetometers as well as other non-invasive techniques such as Airborne Laser Scanning in order to help define more clearly the remains of a battlescape no longer visible to the human eye.

A proposed large landscape project, to cover three large swathes of land in Belgium, would be undertaken using an integrated multidisciplinary approach to investigate the World War I terrain. This would in turn determine what techniques would be most appropriate to apply on an even greater scale, across the different terrains and geologies of the wider landscape.

Acknowledgements

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References

- Bartington, G. and C.E. Chapman (2004) A High-stability Fluxgate Magnetic Gradiometer for Shallow Geophysical Survey Applications. *Archaeological Prospection* 11: 19–34.
- Barton, P. (2011) *The Somme: The Unseen Panoramas*. London: Constable.
- Byledbal, A., B. Rakowski, P. Barton, S. Jones, J. Banning, I. McHenry, J. Porter and R. Porter (2012) *La Boisselle Study Group Archaeological Report: 2012*. Unpublished report.
- Conyers, L.B. (2004) *Ground-Penetrating Radar for Archaeology: Geophysical Methods for Archaeology*. New York: Altamira Press.
- Doyle, P. (1998) *Geology of the Western Front, 1914–1918*. Geologists' Association Guide No. 61. London: Geologists' Association Guide.
- Masters, P. (2007) *Geophysical Survey of the Great War Trenches on Perham Down, Salisbury Plain*. Unpublished report. Cranfield: Cranfield Forensic Institute.
- (2008) Back to Bedlam: Archaeology, Geophysics and Great War Training Landscapes. *ISAP News* 14: 10–12.
- (2014) *Geophysical Survey at the Glory Hole, La Boisselle, France*. Unpublished report. Cranfield: Cranfield Forensic Institute.
- Masters, P. and B. Stichelbaut (2009) From the Air to Beneath the Soil: Revealing and Mapping the Great War Trenches at Ploegsteert, Comines-Warneton, Belgium. *Archaeological Prospection* 16(4): 279–85.

Saey, T., B. Stichelbaut, J. Bourgeois, V. Van Eetvelde and M. Van Meirvenne (2013) An Interdisciplinary Non-Invasive Approach to Landscape Archaeology of the Great War. *Archaeological Prospection* 20(1): 39–44.

Whitehead, R. (2009) *The Other Side of the Wire*. Volume I: *With the German XIV Reserve Corps on the Somme, September 1914 – June 1916*. Hellion: Casemate.

World War I Remains in Scotland: Aerial Photography as Heritage

Allan Kilpatrick

Abstract

Scotland occupies a strategic position between the North Sea and the Atlantic. This put it on the frontline during World War I, prompting the construction of coastal defences and airfields, especially on the North Sea coast. In advance of the centenary commemoration of World War I in Scotland, an audit of all known sites relating to the war was undertaken in 2013. Both the audit and examination of aerial imagery have revealed a more extensive system of land defences around military sites, major naval bases, transport systems and urban areas than was previously known. This chapter reviews aspects of World War I features and structures, drawing on both the audit and the Aerofilms collection of photographs taken during the 1920s and 1930s. Aerofilms was set up by former World War I photo-reconnaissance flyers whose skills were honed during their service above the battlefields of the Western Front. The objective of Aerofilms was to produce aerial photographs for commercial benefit but many images include military features, often recorded by accident, that form now sometimes the only surviving pictorial evidence of many of the sites.

Keywords: World War I, Aerofilms Collection, Scotland, Home Front.

Introduction

This chapter examines the role of historical aerial imagery in recording World War I remains in Scotland and combining archival resources to bring a better understanding of how the war affected Scotland. Lying at the north-western edge of Europe, Scotland occupied a strategic location during World War I, guarding the exit from the North Sea into the Atlantic. Thus it stood on the

frontline of the war at sea throughout the conflict, with a key role in preventing the German High Seas Fleet accessing the Atlantic. The Orkney Islands, the main base for the Grand Fleet, saw with the scuttling of the German Fleet at Scapa Flow on 21 June 1919, arguably the final event of the war.

Military activity expanded greatly across Britain during the war, but particularly so in the north. Scotland became the centre for British naval activity, with the three main bases for the Grand Fleet at Rosyth in the Firth of Forth, Invergordon in the Cromarty Firth and Scapa Flow in the Orkney Islands (Stell 2011). Each required a full range of defences to protect them from attack. Royal Naval Air Service and Royal Flying Corps (RFC) air stations and airships were built to protect coastal shipping, and to mount anti-submarine patrols protecting ship movements (Fife 2007, Smith 1983). On the other side of Scotland, the west coast was a haven for both the fleet and merchant shipping. Mine-layer bases were established to create a minefield across the entire North Sea, mostly by the US Navy in 1918 (Fullinwider 1920). Defences were developed against Zeppelin attacks, with searchlights and anti-aircraft guns. Barracks were expanded or newly built and training grounds established. And, of course, there was the manpower that Scotland contributed to the war, with a greater number per head of population serving than any other part of the UK. The result of this was a higher casualty rate, with a subsequent impact on almost every community in Scotland (see Munro 2014 for an overview of World War I in Scotland).

The World War I remains of this period were audited in Scotland in advance of the centenary (Barclay 2013). This assessment was commissioned by Historic Scotland and the Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS), was completed rapidly, and had four main aims. First, to locate and correctly identify any site within the known records and heritage databases that dated to the period of the war. Second, to discover new sites using available published and archival material from a limited number of sources. Third, to deliver information that could be assessed to determine a designation policy on World War I sites, and thus manage and protect them for the future. Finally, to record all the new information in the national database, also mapping the extents of sites. The assessment drew on a range of sources (including contemporary documents) plans and maps, but early aerial photographs in the Aerofilms Collection (below) proved especially important in the identification, classification and mapping of sites.

The Aerofilms Collection

There is little aerial imagery of Scotland predating the late 1930s, making the aerial photographs taken by Aerofilms Ltd before World War II highly significant. Founded in May 1919, Aerofilms was the UK's first commercial aerial survey company, and drew on experience gained in the Royal Naval Air Service during World War I (RCAHMS 2015, Crawford et al. 2014).

While most of the photographic subjects were recorded for their commercial potential (for example urban areas, large houses, key landmarks), as the earliest aerial images of Scotland they proved to be a valuable source of information for the audit of World War I sites. In many cases, the information of interest today was peripheral to the main subject of the imagery when the photograph was taken; this is a good example of the serendipitous qualities of aerial photographs (whereby information of interest is recorded by accident on imagery taken for another purpose) (Cowley et al. 2010: 1, Fowler 204: 118). In many cases, the benefits of this serendipity applies to a wide range of applications, including archaeology, and the primary sources used tend to be military reconnaissance imagery. In this case the same benefits granted by serendipity apply to the study of military remains captured in commercial aerial photographs. The extent of the information that was extracted from these images is illustrated with reference to selected type sites. Some of this information may be unique, even in what might be considered well-known contexts. For example, the audit (along with later research) has identified in excess of 350 drill halls (Osborne 2006) used by territorial forces (part-time soldiers). For some, like the Brandon Street drill hall in Edinburgh, an Aerofilms image is the only known photographic record of the building. While the Aerofilms Collection has proved to be a remarkable source of information, for some sites the corpus of early aerial images was considerably extended by a discovery at the Museum of Flight (part of the National Museum of Scotland). In 2014 seven albums were found of aerial images taken from airships and planes based in eastern Scotland, France and Belgium. Such small collections can be important, but are often a relatively poorly known resource (see also [Chapter 5](#)).

Coastal Defences and Naval Sites

Coastal batteries and other defences were a reflection of a very real fear of invasion and were dotted along the shore. Many of these batteries have since been lost, such as the Coastguard Battery under the Forth Bridge ([Figure 4.1](#)), although documentary sources and plans remain. However, remaining plans may not be detailed, can often be confusing and may not reflect what was actually built, or may even show structures that were not built at all. Where such sites have been recorded on Aerofilms images, even two decades after the period of interest, the aerial photographs provide evidence to understand what was actually built and to further understand the military use. For example, Broughty Ferry Castle guards the entrance to the River Tay. Documents in The National Archives dating to 1901 and 1907 (WO 78/5193), 1916 (WO 78/5195) and 1921 (WO 78/5196) describe the castle as an artillery school with 4.7-inch guns which lasted until 1929, and a battery of 6-inch guns built to the east of the castle in 1903 during the expansion of defences around the coast of Britain (Maurice-Jones 1957).



4.1 A detail from an Aerofilms 1948 image of the former Coastguard Battery beneath the Forth Bridge. The battery contained two gun emplacements with an observation post, and a magazine and crew shelters below the battery. SC1314756, © RCAHMS (Aerofilms Collection). Licensor www.rcahms.gov.uk



4.2 A detail from an Aerofilms 1932 image of the loop holed wall (A) protecting the east side of the battery. SC1257505, © RCAHMS (Aerofilms Collection). Licensor www.rcahms.gov.uk

This main battery comprised two 6-inch guns with searchlights, a Battery Observation Post, workshop and stores, with the caretaker's garden allotment behind. As a well-known historical landmark, the castle was photographed by Aerofilms, and close examination of the image shows detail not evident in plans and documents (Figure 4.2). This includes a wall with loop holes looking east towards the shore, presumably a defensive measure added after the plans were drawn.

The largest military landscapes in Scotland at this date were created by the Navy. Invergordon in the Cromarty Firth, home to part of the Royal Navy throughout the war, was almost completely taken over for military use. The World War I oil tank still survives, despite bombing during World War II which destroyed one of the tanks. Comparison of an early twentieth-century Navy plan of the town and the 1930 Aerofilms images revealed a previously forgotten hospital, along with the timber building of the Royal Navy Officer's Club. Both of these buildings had been ignored or overlooked in previous recording exercises in the town.

Aerial Warfare

Aerial warfare developed significantly during the war. Extensive infrastructure was created (Delve 2010), some of which survives to the present, and this is generally depicted on Royal Air Force (RAF) maps. Considerable value is added, however, from the aerial photographs and ground visits. At Drem Airfield in East Lothian, for example, a threefold comparison was undertaken; the 1935 Aerofilms image, an RAF plan from 1919 and the buildings still standing today. This led to the identification of four buildings dating from World War I which had survived almost complete abandonment and subsequent rebuilding for World War II. At RAF Leuchars, still an active Army base (it ceased being an RAF base in April 2015), the suite of World War I buildings including two hangers, workshops, offices, hospital, chapel, officer's mess and barracks are still in active use, and many performing their original functions.

Airships were a major part of the aerial capacity of Scotland, with stations for rigid and non-rigid airships providing bases for coastal and anti-submarine patrols along the North Sea coast. These airships required large sheds holding the extensive infrastructure for hydrogen production. No such sheds survive, but three sites do have remains of the hangers still visible. Within a forest in Lenabo in Aberdeenshire, remarkably the bases of three airship sheds have survived, along with elements of the hydrogen plants and airfield buildings (Figure 4.3).



4.3 The sites of the former sheds of the Lenabo airship station, outlined in red, are visible as clearings in dense forestry. The three-shed arrangement is a standard pattern. Background image under licence, © Getmapping plc

Manufacturing

The rapid adoption of a war economy saw significant developments in manufacturing and workers housing. HM Factory Gretna, built to supply cordite, created two new towns of which Gretna was the largest. Such new towns were built to high standards by leading architects of the period, following the principles of the Garden Village scheme. The brick built houses, shops, cinema and churches form the core of Gretna village today. However, the majority of the accommodation for the 11,500 women and 6,000 men housed at Gretna were actually in timber huts, which are recorded in an Aerofilms photograph. These buildings were all thought to have been destroyed,



but a combination of the aerial images, maps and field work show that this is not the case (Cocroft 2000). The photograph made possible the identification of a group of five timber huts in Gretna that are still inhabited today (Figure 4.4).

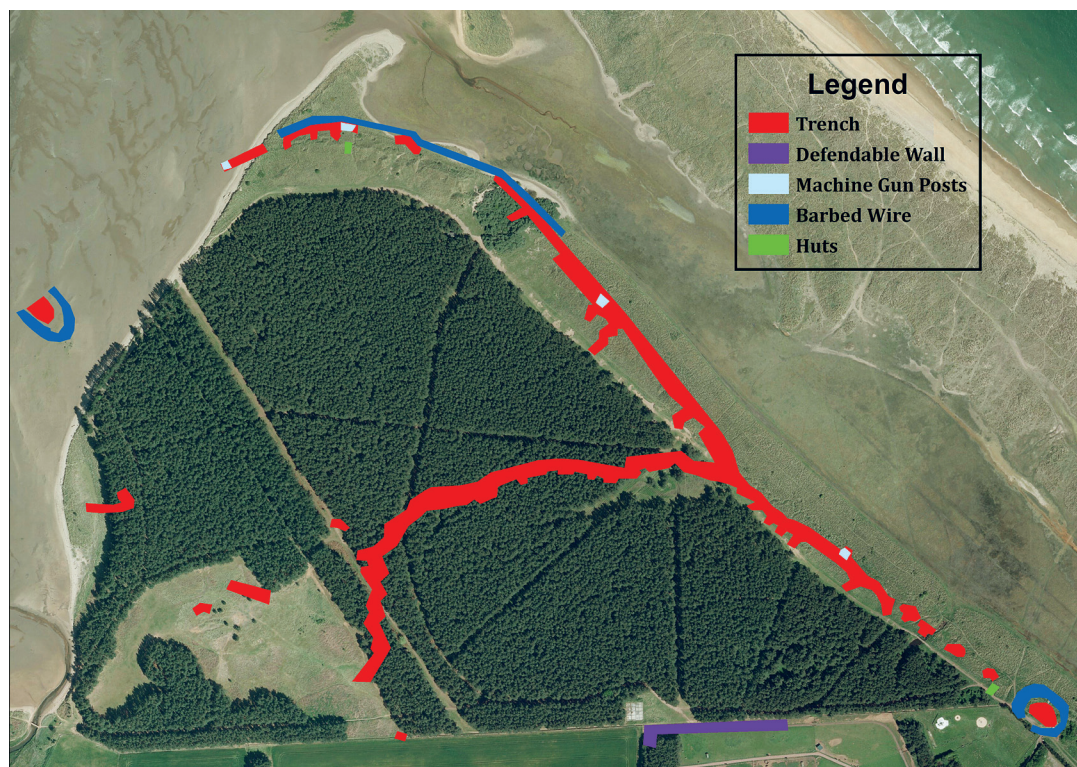
Field Defences

By 1916, with the stalemate on the Western Front, there was a real fear that Germany might invade the east coast of Scotland and destroy the naval bases that were key to blockading the German High Seas Fleet. Attention was therefore turned to reinforcing the River Forth's defences, with redesigns of coastal batteries and the adoption of significant defences in the form of trenches, barbed wire, redoubts, machine-gun posts and block houses (pillboxes). All of these were built at vulnerable points along the coast. The main concentration of these defences was along the rivers Tay and Forth. Rail bridges were particularly heavily defended, as were beaches and obvious routes through Fife and the Lothians (Figure 4.5).

4.4 An Aerofilms view of Gretna in 1929. Gretna was one of two towns built to house 17,500 workers for a vast ammunition factory. Most of the workers' accommodation was in rows of timber huts, a small number of which have survived and are still occupied. SC1256881, © RCAHMS (Aerofilms Collection). Licensor www.rcahms.gov.uk



4.5 Map of the defences along the coast of the Forth and Tay estuaries.
© RCAHMS. Licensor www.rcahms.gov.uk



Maps showing these defences, often in great detail, are held in The National Archives at Kew in London (WO 78/4396). An example at Hedderwick Links near Dunbar in East Lothian (Figure 4.6), shows a large system of beach trenches extending over 2 kilometres in total, some 750 metres of which are still visible as earthworks today. The City of Edinburgh was extensively defended, and detailed maps of the defences were discovered during the audit. These showed a strong network of trenches, redoubts, machine-guns posts, defensible walls, wire entanglements (barbed wire) and defended buildings. These maps also show a system of trenches protecting the approach to Edinburgh from the southeast and east, which were previously completely unknown, and which raised the question of whether this system was ever actually built. However, careful examination of Aerofilms (1951) and RAF (1945) aerial photographs suggested that remains of the system existed in Prestonfield Golf Course near Arthur's Seat in Edinburgh. Subsequently, aerial reconnaissance by RCAHMS also recorded the earthworks of one redoubt, preserved further south in Craigmillar Park Golf Course (Figure 4.7). These defences may have been the only ones ever to see action; this would have been during the successful Zeppelin raid on Scotland in 1916.

4.6 Hedderwick Links – mapping of defences, including trenches, barbed wire, defendable walls and machine-gun posts. Background image under licence, © Getmapping plc



4.7 A small part of the Edinburgh defences survive as slight earthworks in Craigmillar Park Golf Course. A trench system with a front line lies to the left of the trees with a zigzag communication trench extending to the right from the sand bunker. DP175650, © RCAHMS (Aerial Photography Collection). Licensor www.rcahms.gov.uk

Mapping

Digital mapping and the creation of a Geographical Information System (GIS) of the World War I remains was identified as an important outcome of our project. This would help to facilitate further research and management. The value of this data is demonstrated at the Cromarty Battery, where a combined mapping from historical maps and from aerial photographs has created a depiction of all the buildings, each coded with their function and date range (Figure 4.8). In the GIS, detailed coding of all line work in attribute tables allows the many individual features that make up this complex World War I and II battery to be divided into periods, establishing the pattern of rebuilding and re-use at the site. This has helped to confirm that the battery was abandoned between the World Wars and that the accommodation camp was completely rebuilt for World War II.

Conclusion

The audit of World War I remains in Scotland has added considerably to the record of known features. Nine hundred and fifteen sites were recorded, encompassing a range of site types from coastal batteries to drill halls, to hospitals and training trenches. Often complex landscapes of fortifications and military activity have been recorded and mapped for the first time,



transforming our understanding and interpretation of many sites. The audit has mapped the World War I remains by bringing together various archival sources, and this process has been enhanced by the use of a range of aerial images. The outcomes of this project are being used to determine a protection strategy and to educate professionals and the public on the built heritage of this period.

The examination of the early photographs has also provided insights into the thinking of the early aerial photographers, possibly showing their background in World War I. For example, one Aerofilms image of the Cromarty Firth area in 1930 records a trench system visible as a cropmark (Figure 4.9). Not only is this amongst the earliest known photographs of an archaeological cropmark in Scotland, it is likely that the image was taken deliberately and recognised as the site of an in-filled former trench system.

4.8 North Sutor Battery – a modern vertical aerial image with GIS layers overlain. The mapping shows that most of the camp was rebuilt for World War II, and that the gun batteries were adapted and reused. Background image under licence, © Getmapping plc



4.9 A detail of an Aerofilms image taken in 1930 recording cropmarking over an infilled section of the trench system that protected the South Sutor Battery from landward attack. SC1297997, © RCAHMS (Aerofilms Collection). Licensor www.rcahms.gov.uk

References

- Barclay, G. (2013) *The Built Heritage of the First World War in Scotland*. The report of a project commissioned by Historic Scotland & RCAHMS. <http://www.historic-scotland.gov.uk/built-heritage-ww1.pdf> (retrieved 17 February 2015).
- Cocroft, W.D. (2000) *Dangerous Energy: The Archaeology of Gunpowder and Military Explosives Manufacture*. Swindon: English Heritage.
- Cowley, D.C., R.A. Standring and M.J. Abicht (2010) Landscapes Through the Lens: An Introduction. In D.C. Cowley, R.A. Standring and M.J. Abicht (eds) *Landscapes Through the Lens: Aerial Photographs and Historic Environment*. Occasional Publication of the Aerial Archaeology Research Group No. 2, pp. 1–6. Oxford: Oxbow Books.
- Crawford, J., K. Whitaker and A. Williams (2014) *Aerofilms: A History of Britain from Above*. Swindon: English Heritage.
- Delve, K. (2010) *The Military Airfields of Britain: Scotland and Northern Ireland*. Ramsbury: The Crowood Press.
- Fife, M. (2007) *Scottish Aerodromes of the First World War*. Stroud: The History Press.
- Fowler, M. (2004) Archaeology Through the Keyhole: The Serendipity Effect of Aerial Reconnaissance Revisited. *Interdisciplinary Science Reviews* 29(2): 118–34.
- Fullinwider, S.P. (1920) *The Northern Barrage and Other Mining Activities*. United States: Office of Naval Records and Library.
- Maurice-Jones, K.W. (1957) *The History of Coast Artillery in the British Army*. Uckfield: Naval and Military Press.

- Munro, K. (2014) *Scotland's First World War*. Edinburgh: Historic Scotland.
- Osborne, M. (2006) *Always Ready: The Drill Halls of Britain's Volunteer Forces*. Leigh-on-Sea: Partizan Press.
- RCAHMS (2015) *The Aerofilms Collection*. <http://ncap.org.uk/Aerofilms-Limited> (retrieved 10 February 2015).
- Smith, D. (1983) *Action Stations*. Volume 7: *Military Airfields of Scotland, the North-East and Northern Ireland*. Cambridge: Patrick Stephens.
- Stell, G. (2011) *Orkney at War: Defending Scapa Flow*. Volume 1: *World War 1*. Kirkwall: Orcadian.



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Protecting the Home Front: Understanding and Conservation of Twentieth-century Conflict Landscapes in England

Helen Winton

Abstract

The major wars of the twentieth century saw direct effects, for the first time, on most of the civilian population away from the main conflict zones. Mass mobilisation of local resources, people and places were undertaken to support the war effort abroad. By the end of World War II, the use of land for military purposes peaked at about one fifth of the United Kingdom and now constitutes a major part of the historic fabric. The role of aerial photographs, ideally combined with other sources, is central to research into military remains in the United Kingdom and they are a mainstay of identification and understanding archaeological features in landscape contexts. In a heritage protection framework, this can help identify potential places of significance and specifically direct resources when assessing them, and leading to appropriate conservation measures. Information from aerial photographs informs planning decisions, land management plans and other initiatives (such as farm environment schemes). The English Heritage National Mapping Programme is designed to ensure a consistent, quality dataset from aerial photographs and lidar, in order to map and record layered information of all periods from the Neolithic to the Cold War. A case study presents work on the World War I camps at Seaford where aerial photographs are combined with other sources in a desktop study. The Aerofilms Collection and the Britain from Above project demonstrate other uses of aerial photographs in identifying sites relating to World War I. The promotion of understanding and the appreciation of the historic environment is a key part of heritage protection but can be challenging. Engaging with individuals and communities is therefore essential.

Keywords: National Mapping Programme, Seaford, Historic England.

Introduction

This chapter covers the Home Front in England and the role of aerial photographs in studying and conserving the remains of this aspect of military history. Examples are from English Heritage projects and include developing work on the use of aerial photographs for the centenary commemorations of World War I.

The study of the remains of twentieth-century conflict is a relatively recent phenomenon and the discipline has developed in phases. An early emphasis on the classification of sites and collection of data has evolved; more recently, researchers are applying different approaches to provide fresh perspectives (Schofield et al. 2006, Saunders 2012). This includes an appreciation that ‘the complexities of studying wars within living memory demand a new response – a sensitised cross-disciplinary approach’ (Saunders 2012: back cover). Although this chapter stresses the importance of using aerial photographs for research on modern conflict, they are only one of many sources that should be used. Aerial photographs can also be considered historical artefacts, collected during and after the conflicts, in multiple contexts and with complex meanings.

The role of aerial photographs, ideally combined with other techniques, is a recognised, although arguably under used, part of research into military remains in the United Kingdom (Lowry 1995: 9). More generally, aerial photographs are a mainstay of a process to identify and understand archaeological features in landscape contexts. In a heritage protection framework, this can be helpful in targeting other resources used to assess the significance of sites; in turn, this helps put in place appropriate conservation measures (Horne 2011, Van Hollebeeke et al. 2014).

Background

The two World Wars saw the creation and development of the concept of the ‘Home Front’ in Britain. This constituted direct effects on most of the civilian population away from the main conflict zones abroad (Doyle 2012). This was partly through mass mobilisation of local resources, people and places, to support the war effort. This period also saw a new threat to non-combatants in the form of aerial warfare. The threat of direct assault from the air as well as by sea prompted new forms of defence, developed to detect and intercept air raids by planes and airships (Faulkner and Durrani 2008: 48–71). The psychological damage was perhaps far greater than the physical impact on the civilian population but the concept of being on an alternative ‘frontline’, especially on the coast and in the cities, was established in Britain during World War I (Faulkner and Durrani 2008: 8).

The conflicts of the twentieth century therefore had a major physical and social impact on the British landscape and culture. This included the expansion



and adaption of the military and industrial infrastructure resulting in defences on the land, the sea and in the air, along with the development of new and adapted factories drawing on wider demographics for their workforce. New structures and landscapes were required for mobilisation, training and the eventual rehabilitation of those called up to fight in the war. At its peak at the end of World War II it is estimated that about 20 per cent of the land area of the United Kingdom was being used for military purposes (Schofield 2004: 1). The remnants of these twentieth-century conflict landscapes still constitute a major and important part of the historic fabric.

Cliffe Marshes is a well preserved example of the new structures and technology deployed in industrial manufacture of explosives. It can also be appreciated from the air (Figure 5.1). This chemical explosives works, situated at Cliffe Marshes on the Hoo Peninsula in north Kent, covered about 128 hectares by the end of World War I. The site was chosen because of its proximity to the River Thames and relative isolation from settlement (Pullen et al. 2011: 2). The main components of the site survive to the present as ruined structures and well preserved earthworks, due to the continuing use of this area as grazing land. The site was developed from the late nineteenth century but rapidly expanded during World War I, when it became a government-controlled establishment to help meet the unprecedented demand for explosives. These different phases of development can be read from the air, including characteristic earthworks and buildings associated with different manufacturing processes – including those for nitro-glycerine, dynamite

5.1 Remains of the World War I Cliffe Explosives Works by the River Thames on the Hoo Peninsula in north Kent. NMR 26866/041 28 January 2011. © English Heritage

and cordite manufacture. A detailed ground and desk-based study of the site was carried out as part of the Hoo Peninsula Historic Landscape project (Pullen et al. 2011).

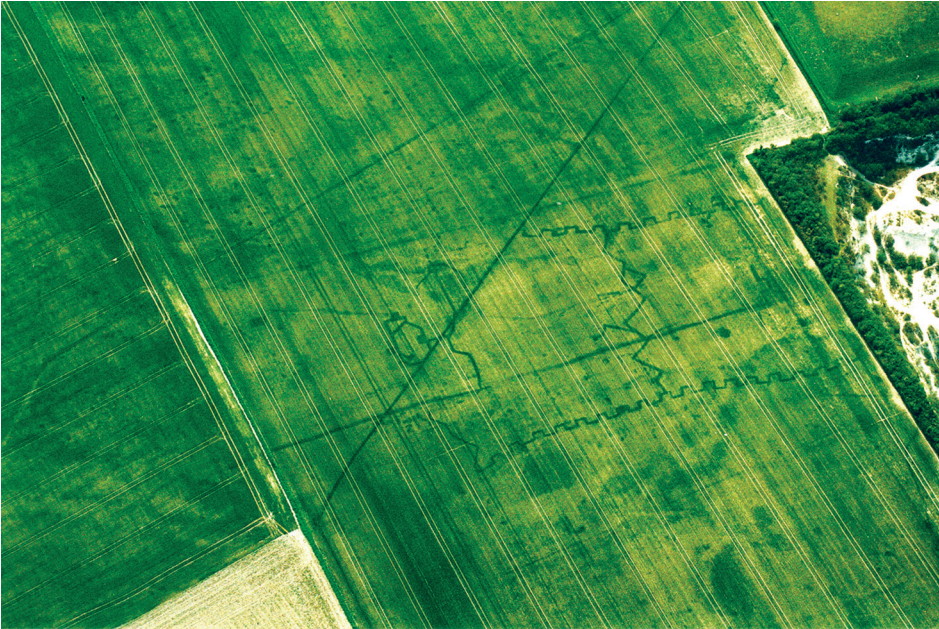
Sources of Aerial Photographs

In England, there are large national sources of aerial photographs, such as the English Heritage Archive and the Cambridge University Collection of Air Photography. Prospection was the original focus of the archaeological oblique photography carried out for these collections. Before the 1980s, this prospection did not usually include modern military features, mainly because they were not considered archaeological or historic. As the remit for study of the historic environment widened, archaeological aerial photography began to cover a range of subjects and perform more functions, including buildings, twentieth century features, and condition monitoring. The English Heritage Archive now includes aerial photographs of a range of subjects including buried sites revealed as cropmarks, illustrations of earthworks and structures, and views designed to record and inform management of sites and landscapes. These include military remains from World War I through to the Cold War.

An example of a site which may once have been classed as ‘non-archaeological’ can be found near Cherry Hinton, by Cambridge. The form and the location of the buried remains of probable World War I training trenches are indicated by cropmarks (Figure 5.2). These trenches are typical of the facsimiles of the front line created for training in numerous locations in Britain. Many trench systems survive as earthworks, but the Cherry Hinton aerial photograph demonstrates that buried remains of trenches can also be identified from the air.

The English Heritage Archive includes many aerial photographs taken for non-archaeological purposes during World War II and throughout the latter half of the twentieth century (Winton and Horne 2010). The wartime photographs tend to concentrate on military sites, or militarily sensitive areas, such as the coast, and we have almost blanket coverage of the country in the post-war years. These show remarkable details of military sites during and after their peak use in World War II, and are an essential resource for research (Cowley et al. 2010, Hanson and Oltean 2013).

A Royal Air Force (RAF) vertical aerial photograph taken in 1946 is a typical example of those held in the English Heritage Archive (Figure 5.3). It shows part of Aston Down airfield, formerly RAF Minchinhampton. This was established during World War I, closed in 1920 and reopened just before World War II. It continued as RAF Aston Down after 1945, initially to test the Fairy Rotodyne rotor blade assembly. The main runway is still in use by the Cotswold gliding club and most of the World War II technical buildings and hangars remain at the site. It was mapped and recorded as part of an archaeological aerial survey of the Cotswold Hills in Gloucestershire (Janik et al. 2011).



5.2 Buried remains of World War I training trenches revealed as cropmarks near Cherry Hinton, by Cambridge. NMR 21608/15 16 April 2002. © English Heritage



5.3 Extract of English Heritage Archive 1946 RAF vertical aerial photograph showing part of Aston Down airfield (formerly Minchinhampton). RAF/3G/TUD/UK/102 VP2 5161 30 March 1946. © English Heritage (RAF Photography)

There are small collections of aerial photographs taken in the 1920s and 1930s that form a good source of information on pre-war Britain, such as the Allen Collection at the Ashmolean Museum and the Crawford Collection at the English Heritage Archive. These inevitably reflect the interests of Crawford and Allen, who collected or took aerial photographs with mainly ‘traditional’ archaeological subjects seen as cropmarks or earthworks. However, the Crawford Collection includes aerial photographs of the substantial and extensive training trenches on Salisbury Plain Training Area and some other military subjects (Figure 5.4). This is almost certainly because Crawford acquired his collection from the military – the aerial photographs he chose (or requested to be taken) therefore serendipitously include military features. However, Crawford’s interest was the earlier archaeology rather than a record of the recently dug military features.

One view, taken in 1928, is mainly of Stonehenge but also records the surviving parts of the World War I aerodrome in the background (Figure 5.4). The buildings nearest to Stonehenge (two huts and a smaller latrine structure) on the left of the frame are related to archaeological excavation. The airfield was in use from 1917 to early 1918 by the Royal Flying Corps training establishment and then became the No. 1 School of Aerial Navigation and Bomb Dropping. It was closed in 1921 and re-use of the site for agricultural and domestic purposes prompted debate on the proper setting for the Stonehenge monument resulting in a public appeal (Barber 2014). Indeed, the photograph may have been requested or collected by Crawford for use as part of the Stonehenge Appeal (Barber 2014: 77–8).

The extensive Aerofilms Collection includes aerial photographs of a range of subjects, including factories, townscapes and major events, taken from 1919 onwards (Crawford et al. 2014). This collection, much of it available online through the Britain from Above project, includes aerial photographs of many sites with direct links to World War I. These have already proved extremely useful as a source of new information on previously unknown sites and landscapes (see also Chapter 4).

It can be hard to find aerial views of the Home Front taken during World War I as most of the aerial photographs held in the national collections are of the Western Front or other conflict zones abroad. There are some held in private collections but these can be difficult to locate or access. For example, colleagues came across rare early aerial photographs of the World War I aerodrome at Stonehenge by chance on the walls of one of the local pubs near Salisbury. A personal archive of World War I period photographs (the Charles Pulman Collection) was drawn to our attention when someone heard a colleague talking on the radio about the history of aerial photography (P. Horne pers. comm.). The Charles Pulman Collection includes aerial photographs of a range of subjects in diverse locations including the Western Front and the south of England. These may have been collated in the immediate post-war period for an exhibition, possibly linked to the origins of the Imperial War Museum (M. Barber pers. comm.)



Heritage Protection Context

English Heritage has developed a framework, called the National Heritage Protection Plan, to promote strategic organisation of research and other activities that lead directly to heritage protection outcomes. This framework is used by English Heritage to target resources and plan activities to achieve appropriate protection measures for the historic environment (English Heritage 2013b). One of the aims of the National Heritage Protection Plan is to promote identification, understanding and conservation of the physical remains of twentieth-century conflict in England (English Heritage 2013a: 18, 20, English Heritage 2013b: 44, 68–9).

A main role of aerial photographs in heritage protection is the discovery and recording of archaeological sites. This is done from the knowledge that you cannot protect something if you do not know where, and what, it is. In the National Heritage Protection Plan this falls under the measures grouped as ‘building the evidence base’, in particular the measure characterised as ‘identification and recognition’ (English Heritage 2013b). Aerial photographs are arguably one of the greatest sources of information on the location and general character of archaeological sites and landscapes in England (Horne 2011: 146). The National Heritage Protection Plan therefore has an activity

5.4 Stonehenge with the World War I aerodrome in the background. CCC 11796/4519 12 July 1928. © English Heritage (Crawford Collection)

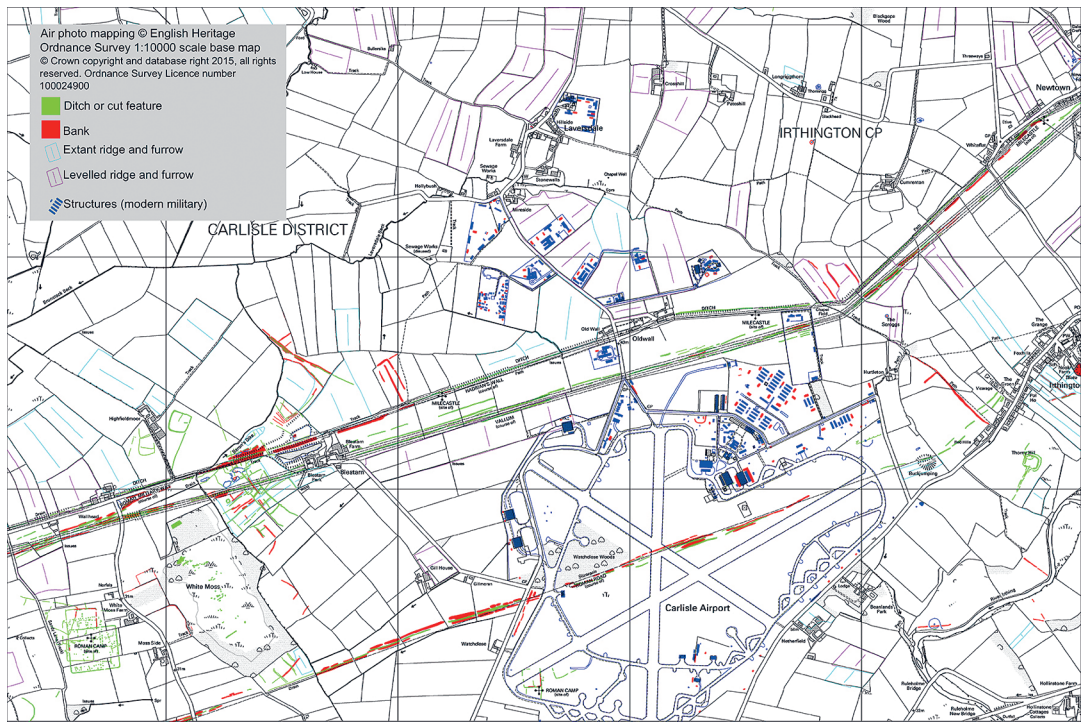
devoted to aerial reconnaissance and landscape projects led by analysis and mapping from aerial photographs (English Heritage 2012: 48–52). This is used to implement heritage protection measures and to target appropriate research and complementary survey techniques.

Bringing It All Together: Aerial Investigation and Mapping

The main processes involved in ensuring the information derived from aerial photography is effective for heritage protection and research involve ‘mining the archives’ to create an archaeological map and monument records. These are collated in a Historic Environment Record so that the information feeds directly into planning decisions, land management plans and other initiatives (such as farm environment schemes). A synthesis, usually a report, will give a landscape overview and provide a framework for further targeted work (for example Carpenter et al. 2013). The importance of good quality information in the historic environment record cannot be underestimated. The English Heritage national standards, under the banner of the National Mapping Programme, are designed to ensure a consistent, good quality dataset from aerial photographs and lidar (Horne 2011, Winton and Horne 2010).

The National Mapping Programme standards advocate using all available sources of aerial photographs and recording all information – from the Neolithic up to the Cold War, and including earthworks and structures, or buried remains revealed as cropmarks. The resulting interpretations and maps, when viewed in a historic environment record, encourage a layered view of the landscape. Aerial evidence, and information from other sources and survey techniques, provides glimpses of the changing use of an area potentially over thousands of years. This is an important viewpoint for heritage protection, which considers all known aspects of the past land use in the context of managing future change.

Multiple layers of information can be seen on mapping from aerial photographs and lidar of part of an area around Hadrian’s Wall (Figure 5.5). This mapping was completed during a National Mapping Programme survey of the Roman frontier in northern England (Small 2008, Oakey 2009). The mapping depicts aspects of different land use over a period of at least 2,000 years. This includes prehistoric or Roman settlement, Roman military camps, and the turf wall, *vallum* and military way that extend right across the landscape. There are further phases of land use, including medieval cultivation seen as ridge and furrow. Overlying all this is a World War II military landscape associated with the airfield and ancillary buildings of what later became Carlisle Airport. The mapping and attached monument records are designed for integration into the historic environment record. They therefore depict the physical form and extent of the remains, provide an interpretation of period and type, and document the sources used. This forms part of a powerful package of information accessed through a Geographical Information System (GIS) which can be used for landscape research, heritage protection and planning.



The results of our projects can be developed as part of thematic work, aimed at the assessment of the significance of particular areas, themes and site types. The National Heritage Protection Plan also has an activity devoted to twentieth-century military heritage. This activity has a wide remit covering many different disciplines and approaches. As part of this work, we are developing projects to be carried out during the 1914–18 centenary. We have identified a series of topics to be explored using a variety of techniques. These are subjects where we feel there is more to discover, and where a better understanding is required to assess significance and thereby plan appropriate management strategies. These include military fieldworks, training areas and camps, the national factories, aviation (principally airfields and balloon sites), hospitals, military communications and intelligence, and maritime sites. These initiatives will involve work by English Heritage, grants for projects and advice for community led projects.

As our work is focused on heritage protection, much of the detailed work will inevitably concentrate on the surviving remains. However, surveys will include assessment of the original form and extent of some of the lost components of sites and landscapes as recorded on aerial photographs, ground photographs and in documentary sources. Projects should always aim to tie these places to people, memories and wider social contexts. This will often include applying multiple techniques and involvement of members of the public.

The potential role of aerial photographs in future projects can be demonstrated in previous work. The areas for our landscape projects are usually

5.5 Interpretation and mapping of archaeological features visible on aerial photographs and lidar of part of Hadrian's Wall and environs near Carlisle Airport. NMP mapping, © English Heritage. Background map, © Crown copyright and database right 2015, all rights reserved. Ordnance Survey Licence number 100024900

defined by management issues or a perceived lack of knowledge, not because there is a particular period of interest. Therefore, any World War I military landscapes mapped from aerial photographs and Airborne Laser Scanning are usually surveyed in a wider context rather than as part of a thematic recording project. For example, projects designed to feed into management of the coast recorded extensive landscapes of military coastal defences, mainly from World War II, but including some elements from World War I (Hegarty and Newsome 2007, Wessex Archaeology 2011, Dickson et al. 2012, Royall 2014). Work in future may have stronger ties to themes such as the 1914–18 centenary and could include landscapes with strong links to World War I such as the Cannock Chase area (Whitehouse and Whitehouse 1996).

SEAFORD CAMPS

When our large landscape projects identify new evidence for exceptional sites, we can explore further. For example, two large World War I training camps at Seaford were included in a survey looking at many aspects of the landscape on part of the south coast of England (Carpenter et al. 2013). This presented an opportunity for an Institute for Archaeologists and English Heritage Professional Placement in Conservation to map and assess these important sites, and to demonstrate the skills required for a desktop study using aerial photographs as a main source (Skinner 2011).

The camps were known and had been investigated by the local archaeological society, but the few surviving remains were difficult to identify on the ground due to extensive development and changes in the area in the last 100 years. The systematic study of all available aerial photographs, and the resultant mapping and recording, demonstrated that the camps were more extensive than previously thought. They also accurately located the form and extent of the surviving remains.

The Seaford study highlighted the effectiveness of looking at all available air photographs, and not just the earliest, which might be assumed to show the fullest extent of the site. A set of early 1950s RAF aerial photographs taken in low raking light highlighted the remains of the camp in remarkable detail (Figure 5.6). As far as we are aware, these photographs had never been assessed. This prompted further work and an opportunity to collaborate with the Sussex Archaeological Society, along with other locals researching the site. Rob Skinner was able to access wartime postcards at the Seaford Museum along with plans and illustrations of the camp available online from the Canadian Archives. These were useful supplementary sources for details of camp architecture and layout. This included welfare buildings such as the YMCA but also temporary structures, such as tents, that are less likely to leave visible traces. Just as important was that these other sources brought in a more human dimension, obtaining glimpses of the experience of the people who passed through these camps. Linking this to previous research and contemporary written accounts, we can speculate on what life was like in the camps. We can also start to explore the potential effects of the massive influx of new soldiers on the local population.



5.6 Extract of 1951 vertical aerial photograph showing earthworks of buildings and post holes associated with one of the World War I camps by Seaford, East Sussex. The roof of a surviving Armstrong Hut is top centre of the frame on the edge of a former parade ground. RAF/58/613 RS 4237 5 April 1951. © English Heritage (RAF Photography)

The results at Seaford demonstrated how using aerial photographs could highlight management issues. The mapping from aerial photographs tied the contemporary plans for the camps to georeferenced positions on the ground. This helped to identify parts of the camp hidden by gorse and other dense vegetation. Foundations of different building types could be more positively categorised and seen in the context of the lost elements of the camp.

The project raised some dating issues of fieldworks associated with military training, in particular the trench systems that have become something of an icon for World War I. Few official records of training trenches survive, so it can be difficult to identify those constructed during the 1914–18 conflict from those created as part of later phases of military activity. Context and relationships to other features can provide clues – as seen at Seaford. A 1942 aerial photograph shows what look like freshly dug trenches cut into parts of South Camp and co-located with World War II activity (Figure 5.7). When mapped from aerial photographs, this network of trenches can be seen to overlie buildings marked on the 1916 plan of South Camp, and are in an area of buildings depicted on wartime postcards and immediate post-war paintings (Skinner 2011: 28–9, Fig. 22). Anecdotal evidence suggests that trenches were dug in the Seaford area, possibly by the Territorial Army, in the late 1930s (Skinner 2011: 28).

5.7 Extract from 1942 vertical aerial photograph of the southern part of the World War I

South Camp at Seaford, East Sussex. Trenches appear to overlie parts of the camp raising questions about dating. Vehicle tracks and the V-shaped arrangement of barbed wire (lower centre of photo) are World War II features. RAF/HLA/538 V 6 11 8 May 1942. © English Heritage (RAF Photography)



The appearance of the earthworks on the 1942 aerial photographs suggests that the more northern parts of this trench system had been in place for some time while the fresh appearance of the white chalky spoil in the lower areas suggests they were newly created or re-cut in shortly before 1942 (Figure 5.7). It is therefore likely that the trenches on the edge of South Camp do not belong to World War I but are related to training before and possibly during World War II. This example demonstrates the potential difficulties in dating trench systems and how the use of multiple sources, and analysis of earthworks, can help narrow the potential timeframe for construction. Other trenches in the area, seen as earthworks and as cropmarks, are almost certainly linked to the 1914–18 camps but closer dating requires further work (Skinner 2011: 26–31). It is hoped that this issue may be resolved by looking nationally at fieldworks associated with military training using multiple survey and research techniques to more closely define chronologies and types.

Perhaps the most rewarding aspect of the work at Seaford was the mutually beneficial collaboration with the local archaeological society. The promotion of understanding and appreciation of the historic environment needs to be a key part of the process of heritage protection, but can also be challenging. Engaging with individuals and communities is essential and a lot of excellent work is carried out by organisations such as the Council for British Archaeology and by local groups and societies (Moshenska and Dhanjal 2011, Skeates et al. 2012, Historic Environment Forum 2014).

Home Front Legacies and Community Engagement

There are many initiatives to promote understanding of World War I during the centenary period. An important one for heritage protection involved a trial to develop methods for engaging people with the places associated with the war. The Home Front Legacy 1914–18 project encourages a move from simply identifying and categorising surviving fabric from World War I towards a broader definition of the historic environment that links places to significant events and people. An important outcome of the project trial was an online toolkit for systematically recording surviving remains that can be fed into the historic environment record (Glass et al. 2014). The project is being promoted and run by the Council for British Archaeology principally through their website. Involving aerial photographs in this sort of initiative could help to unlock important, but hard to acquire, contemporary sources for the Home Front.

The Britain from Above project is using a form of crowd sourcing to add information to their online collection. They are currently promoting tagging of information related to World War I. The Britain from Above website has a 1920 aerial photograph of the Brunner Mond and Company Limited building, one of the National Factories created to manufacture explosives on behalf of the Ministry of Munitions during World War I (Figure 5.8). The factory opened in 1917 in Stratton St Margaret, which is now a suburb of Swindon, and was designed to produce ammonium nitrate. The exact location of the factory was unknown until the Aerofilms photograph was made available through the Britain from Above project.

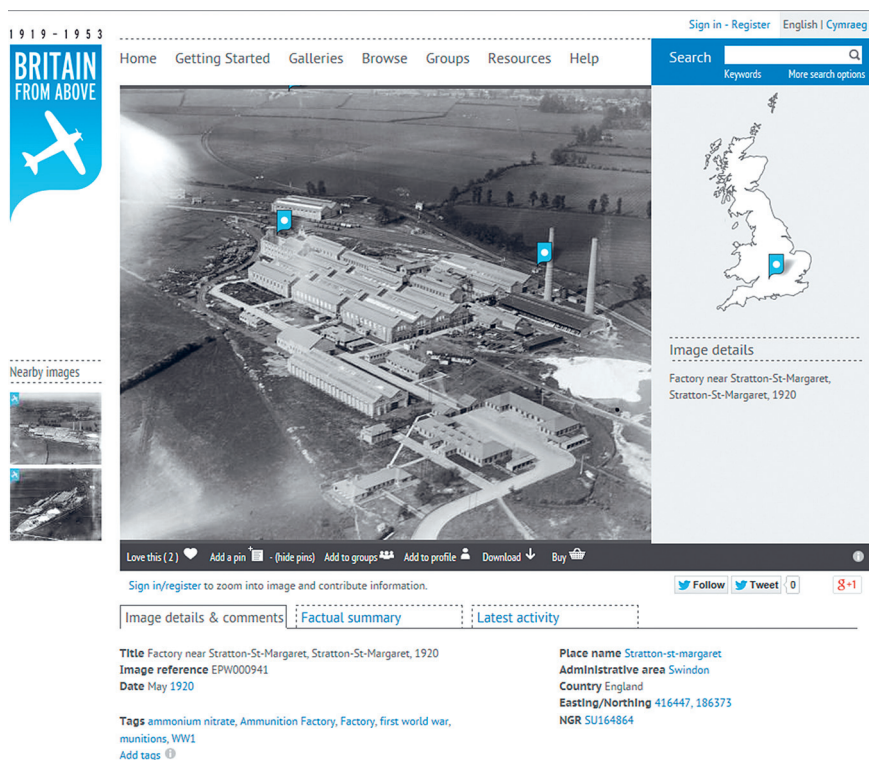
The information added to the website by a member of the public is as follows:

This is the First World War ‘powder works’, which is now part of Kembrey Park/Elgin Industrial Estate. The two tall chimneys in the picture were taken down in the Second World War because it was thought they would be an aid to navigation for enemy bombers. Towards the back of the picture is the ‘Bunky Bridge’ over the old Swindon/Highworth branch line. The bridge was demolished c1970, soon after the line became disused. The area to the right of the line is now a huge BMW factory, turning out panels for Minis. (Carter 2014)

This is not the usual format of a historic environment record but it provides an interesting personal view of changes and how this relates to what we see today. Use of aerial photographs can be perceived as difficult in certain contexts (Brophy and Cowley 2005) but the Britain from Above project is a good example of where the general public can use their own knowledge and provide fresh perspectives on the aerial view.

A final example of community groups using aerial photographs involves the Finding the Forgotten and Wiltshire Field Group. They have been working at various sites in north Wiltshire including using aerial photographs to help place their fieldwork on World War I sites and landscapes in context.

5.8 The Britain from Above website showing the World War I nitrate factory at Stratton St Margaret (now a suburb of Swindon) with tags added by members of the public. The project is encouraging people to look for World War I images. Image is supplied courtesy of English Heritage, RCAHMW and RCAHMS from the jointly owned Britain from Above website



Their work at Yatesbury Airfield and German Prisoner of War camp draws on a variety of techniques on a site that is now mainly arable fields with few above-ground remains visible. The material culture discovered included objects from the German prisoners as well as a wide range of airfield-related items. Rare contemporary aerial photographs were used to communicate to volunteers the layout and original form of these very large sites and to give further meaning to the finds. The community-based work also demonstrated that despite being 'lost' there are important elements of these sites surviving to explore and understand (Finding the Forgotten 2015).

Conclusion

The major effect of World War I on the people at home is relatively well known in the UK. During the centenary period, this is being explored and promoted in the media, for example by the BBC, and projects are encouraged in local communities, mainly through the Heritage Lottery Fund 'First World War: Then and Now' initiative. However, there are less well understood aspects of the Home Front, such as the extent of the physical impact of training and other military infrastructure on the urban and rural environment. As World War I passes out of living memory, the physical remains form an increasingly

important and tangible legacy of the conflict (see also [Chapter 17](#)). We need a better understanding of the location and significance of the surviving and lost elements of these military sites and landscapes to ensure appropriate protection and presentation. Heritage professionals and the general public can help by applying a range of approaches and ensuring that the resulting information is accessible. Aerial photographs, and the mapping derived from them, clearly have a key role to play in the study of the Home Front. They can be used for discovery and better understanding but are also an important source of inspiration.

Acknowledgements

Thanks to my colleagues in Aerial Investigation and Mapping, in particular Martyn Barber, for advice. Thanks to the English Heritage Archive and the Britain from Above project for use of their images. English Heritage will divide into two organisations in April 2015 and the archive will become part of Historic England. English Heritage and National Mapping Programme reports and National Heritage Protection Plan documents will be available to download from the Historic England website. Dan Miles kindly supplied information on the work of the Finding the Forgotten and Wiltshire Field Group – see their websites for more information. Information on the Home Front Legacy is on the Council for British Archaeology (CBA) website. Information on the Heritage Lottery Fund ‘First World War: Then and Now’ is on their website.

References

- Barber, M. (2014) *Stonehenge World Heritage Site Landscape Project: Stonehenge Aerodrome and the Stonehenge Landscape*. Research Report Series 7–2014. English Heritage Internal Report.
- Britain from Above. <http://www.britainfromabove.org.uk/> (retrieved December 2014).
- Brophy, K. and D.C. Cowley (2005) *From the Air: Understanding Aerial Archaeology*. Stroud: Tempus.
- Carpenter, E., M. Barber and F. Small (2013) *South Downs: Beachy Head to the River Ouse, Aerial Investigation and Mapping Report*. Research Report Series 22–2013. English Heritage Internal Report.
- Carter, Graham (June 2014) Tag added to the Britain from Above website. <http://www.britainfromabove.org.uk/image/epw000941> (retrieved December 2014).
- Cowley, D.C., R.A. Standring and M.J. Abicht (eds) (2010) *Landscapes Through the Lens: Aerial Photographs and Historic Environment*. Occasional Publication of the Aerial Archaeology Research Group No. 2. Oxford: Oxbow Books.
- Crawford, J., K. Whitaker and A. Williams (2014) *Aerofilms: A History of Britain from Above*. Swindon: English Heritage.

- Dickson, A., J. Janik, R. Priest and C. Royall (2012) *South East Rapid Coastal Zone Assessment Survey: National Mapping Programme Components 1&2. NHPCP Project Numbers 6105 and 6106: Results of NMP Mapping*. Gloucestershire County Council and Cornwall Council Internal Report for English Heritage.
- Doyle, P. (2012) *First World War Britain: 1914–1919*. Oxford: Shire.
- English Heritage (2012) *National Heritage Protection Plan 2011–15: Annual Report May 2011–March 2012: Activity Programme*. Compiled by English Heritage March 2012. Swindon: English Heritage.
- (2013a) *National Heritage Protection Plan 2011–2015: Framework*. Swindon: English Heritage.
- (2013b) *National Heritage Protection Plan: Action Plan 2011–15. Revision 2: April 2013–March 2015*. Swindon: English Heritage.
- Faulkner, N. and N. Durrani (2008) *In Search of the Zeppelin War: The Archaeology of the First Blitz*. Stroud: Tempus.
- Finding the Forgotten (2015) *Yatesbury Aerodrome Community Project*. <http://www.findingtheforgotten.co.uk/archaeology-projects/yatesbury> (retrieved 16 April 2015).
- Glass, E., N.J. Saunders and J. Schofield (2014) *The Home Front (1914–1918) and Its Legacies: A Pilot Study for a National Public Archaeology Recording Project of First World War Legacies in Britain: 2014–2018*. University of Bristol, University of York, Council for British Archaeology and English Heritage Internal Report.
- Hanson, W.S. and I.A. Oltean (eds) (2013) *Archaeology from Historical Aerial and Satellite Archives*. New York: Springer.
- Hegarty, C. and S. Newsome (2007) *Suffolk's Defended Shore: Coastal Fortifications from the Air*. Swindon: English Heritage.
- Historic Environment Forum (2014) *Draft Heritage 2020 Framework*. <http://www.theheritagealliance.org.uk/historic-environment-forum/heritage2020> (retrieved 5 January 2015).
- Horne, P. (2011) The English Heritage National Mapping Programme. In D.C. Cowley (ed.) 2010 *Remote Sensing for Archaeological Heritage Management*. EAC Occasional Paper No. 5 / Occasional Publication of the Aerial Archaeology Research Group No. 3, pp. 143–51. Brussels: Europae Archaeologia Consilium.
- Janik, J., A. Dickson and R. Priest (2011) *An Archaeological Aerial Survey in the Cotswold Hills: A Report for the National Mapping Programme*. Gloucestershire County Council Internal Report for English Heritage.
- Lowry, B. (1995) *20th Century Defences in Britain: An Introductory Guide*. CBA practical handbooks in archaeology, No. 12. York: Council for British Archaeology.
- Moshenska, G. and S. Dhanjal (2011) *Community Archaeology: Themes, Methods and Practices*. Oxford: Oxbow Books.
- Oakey, M. (2009) *Hadrian's Wall World Heritage Site: National Mapping Programme Project Summary Report*. Research Report Series 73–2009. English Heritage Internal Report.
- Pullen, R., S. Newsome, A. Williams and W.D. Cocroft (2011) *Curtis's and Harvey Ltd Explosives Factory, Cliffe and Cliffe Woods, Medway*. Archaeological Survey and Analysis

- of the Factory Remains*. Research Department Report Series 11–2011. English Heritage Internal Report.
- Royall, C. (2014) *Rapid Coastal Zone Assessment Survey for South-West England: South Coast Dorset. Component One: National Mapping Programme, English Heritage Project Number 6673*. Cornwall Council Internal Report for English Heritage.
- Saunders N.J. (ed.) (2012) *Beyond the Dead Horizon: Studies in Modern Conflict Archaeology*. Oxford: Oxbow Books.
- Schofield, J. (2004) *Modern Military Matters: Studying the Twentieth-century Defence Heritage in Britain: A Discussion Document*. York: Council for British Archaeology.
- Schofield, J., A. Klausmeier and L. Pubrick (eds) (2006) *Re-mapping the Field: New Approaches in Conflict Archaeology*. Berlin: Westkreuz-Verlag.
- Skeates, R., C. McDavid and J. Carman (2012) (eds) *The Oxford Handbook of Public Archaeology*. Oxford: Oxford University Press.
- Skinner, R. (2011) *Kitchener's Camps at Seaford: A First World War Landscape on Aerial Photographs*. Research Department Report Series 27–2011. English Heritage Internal Report.
- Small, F. (2008) *Hadrian's Wall NMP Project – Brampton to Birdoswald: National Mapping Programme Report*. Research Department Report Series 73–2009. English Heritage Internal Report.
- Van Hollebeeke, Y., B. Stichelbaut and J. Bourgeois (2014) From Landscape of War to Archaeological Report: Ten Years of Professional World War I Archaeology in Flanders (Belgium). *European Journal of Archaeology* 17(4): 702–19.
- Wessex Archaeology (2011) *South East Rapid Coastal Zone Assessment Survey (SE RCZAS). Phase 1: National Mapping Programme Report – Blocks B, C, L and M*. Wessex Archaeology Internal Report for English Heritage.
- Whitehouse, C.J. and G.P. Whitehouse (1996) *A Town for Four Winters: An Original Study of Military Camps on Cannock Chase during the Great War, 1914–19*. Brocton: Whitehouse.
- Winton, H. and P. Horne (2010) National Archives for National Survey Programmes: NMP and the English Heritage Aerial Photograph Collection. In D.C. Cowley, R.A. Standring and M.J. Abicht (eds) *Landscapes Through the Lens: Aerial Photographs and Historic Environment*. Occasional Publication of the Aerial Archaeology Research Group No. 2, pp. 7–18. Oxford: Oxbow Books.



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Airborne Laser Scanning and the Archaeological Interpretation of Ireland's World War I Landscape: Randalstown Training Camp, County Antrim, Northern Ireland

Heather A. Montgomery and Rory W.A. McNeary

Abstract

The training of Irish soldiers for service in the British Army during World War I required the establishment of training camps across the island, such as at Shane's Castle Estate, close to Randalstown in County Antrim, Northern Ireland. The camp saw active use from 1914 to 1918 but after the war it was demilitarised and returned to use as farmland. Archaeological investigations have revealed that earthwork traces of the camp can still be identified in the modern landscape. Comparison of a map of the camp from 1915, Airborne Laser Scanning data and aerial photographs have enabled the footprint of the camp to be re-established, while also helping to identify the location of specific elements such as the remains of barrack huts, stores, mess halls and officers' quarters.

Keywords: Airborne Laser Scanning (ALS), Home Front, Ireland, Randalstown, training camps, World War I.

Introduction

It is now widely recognised that the vestiges of World War I extend far beyond the Western Front battlefields. As highlighted by Brown and Field (2013: 291–300) they survive at numerous locations within the 'Home Front' landscape, offering testament to our twentieth-century era of warfare in Britain and Ireland at a time when Ireland was still tenuously part of a wider British Empire. These traces can be identified amidst the large expanses of the modern-day military estates, as well as other less commonly associated

areas of the countryside – relict landscapes of where and how soldiers were prepared and trained for war.

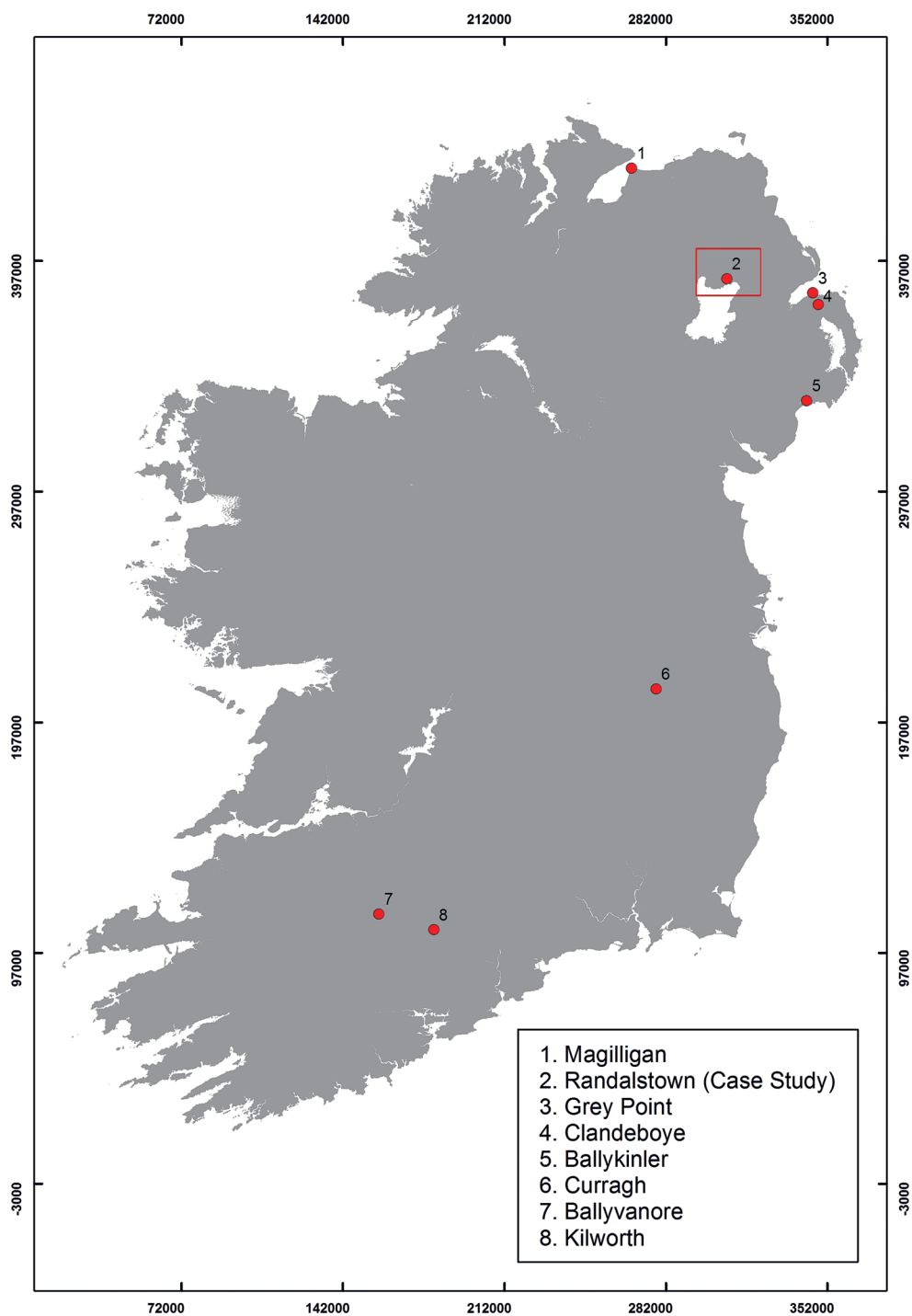
The training of Irish soldiers for service in Kitchener's New Army during the first months of the war required the establishment of training camps across the island. These camps were in most cases hastily constructed and of a temporary fabric, and facilitated the housing of tens of thousands of newly enlisted men who had volunteered to join the British Army. Archaeologists in Ireland are now considering the sites of these former training camps as archaeologically significant and are searching for vestiges of these relict militarised landscapes.

In 1914, following the declaration of war on Germany, an area within Shane's Castle Estate became a formal British Army training camp, and from 1916 a Command Depot. After the war the camp was returned to use as farmland. Its location in the modern landscape was re-established in 2013 as part of a wider archaeological study utilising Airborne Laser Scanning (ALS) data (McNeary 2014a). It is now one of a number of World War I training camps in Ireland that are being studied as part of a multidisciplinary research programme based at Queen's University Belfast (QUB) (Figure 6.1). The principal objective of this programme is to generate a detailed inventory of these training sites across Ireland, based on desk-based assessment and fieldwork.

This chapter describes the effective integration and GIS mapping of historical cartography, aerial photographs and ALS data and demonstrates, via the interpretation of these data, the methods by which the ephemeral remains of World War I landscapes can be visualised and better understood. Historical interpretations and archives are also used to enrich and augment the current narratives of Ireland's involvement in World War I. By illustrating the combined use of official histories and contemporary mapping with remote sensing data, this will present a positive non-invasive means of understanding, recording and engaging with the material culture of World War I on the 'Home Front' in Ireland. This work will ultimately assist in the future conservation and heritage management of these often overlooked and threatened historic landscapes.

World War I Archaeology in Ireland

Ireland raised three Divisions for Kitchener's New Army; all were equipped and trained on the island in a number of military camps spread across the country. As part of this process recruits were required not only to practice efficient trench construction, but also to spend time in facsimile systems, living under simulated, but realistic, conditions to that of the front. Many of these trench systems were constructed on pre-existing military camps, such as Magilligan Camp, County Londonderry, Kilworth, County Cork and Ballykinler, County Down; others were in more public settings such as Phoenix Park, Dublin and Lurgan Park in County Armagh.



6.1 Location of World War I training camps under study; Randalstown case study area marked by red box. © Crown Copyright and authors

The vestiges of many of these trenches still survive today, although they have as yet to be fully surveyed or archaeologically investigated.

The physical legacy of Ireland's World War I experience is currently under-researched when compared with areas of England, such as Salisbury Plain, where archaeological investigations on contemporary sites have revealed considerable detail as to how troops were prepared for the travails of war, offering insights into the extent to which trench construction was practised as well as the occupation, use and re-use of the trenches during the training process, frequently carried out under live-fire conditions (McOmish et al. 2002).

The historiography of World War I in Ireland has hitherto been a contentious and divisive subject due to the historically divided loyalty of the Irish populace to the British Crown and the idea of a United Kingdom. However in recent times, World War I studies have made positive advances towards cultivating a more collective narrative of World War I; therefore, it is important to strive to comprehend and preserve the physical legacy as part of that historiography. With the exception of war memorials it is almost impossible to see any visible remains of the conflict as it would have been on the 'Home Front'; and, unless one knows where to look there is little to be seen of these vast training camps, or indeed other structures such as pill boxes, practice trenches and gun emplacements. Current investigations combine the archaeological record with contemporary historic archives, attempting to identify what remains today, and substantiating what was thought to have been constructed in Ireland during 1914–18. If not an unknown part of Irelands heritage, this period is undoubtedly a vastly under researched one.

This gap in our current knowledge has begun to be addressed by ongoing research initiatives at QUB, in partnership with the Northern Ireland Environment Agency (Northern Ireland Environment Agency 2015), the Living Legacies 1914–18 Project (Living Legacies 1914–18 2015) and the Council for British Archaeology Home Front Legacy Project (Council for British Archaeology 2015). Additionally recent work has been undertaken at The Curragh, County Kildare, as part of a BSc in geomatics involving the study of the training trenches via the application of ALS (McCarthy 2014).

The Archaeological Application of ALS in an Irish Context

In the course of the last decade the archaeological application of ALS has increased with remote sensing techniques frequently being used to construct detailed topographic maps for the prospection and mapping of archaeological landscapes, including a relatively early application at Loughcrew, County Meath (Shell and Roughley 2004). This project illustrated the utility of ALS in Ireland as a landscape modelling technique, reinforced by subsequent Heritage Council projects, such as Tara (Corns et al. 2008, Corns and Shaw 2009) and Brú na Bóinne, County Meath (Davis et al. 2013, Megarry and Davis 2013: 81–91), Dún Ailinne, County Kildare, and Skellig Michael, County Kerry

(Corns and Shaw 2013). In Northern Ireland recently published studies have utilised both NIEA-commissioned high resolution (0.125–0.250 metre) ALS data and 'off-the-shelf' lower resolution (1 metre) data (see McNeary 2014a, McNeary 2014b and McNeary 2014c); these latter studies have proved extremely useful for archaeological prospection and by extension improved cultural heritage management (CHM).

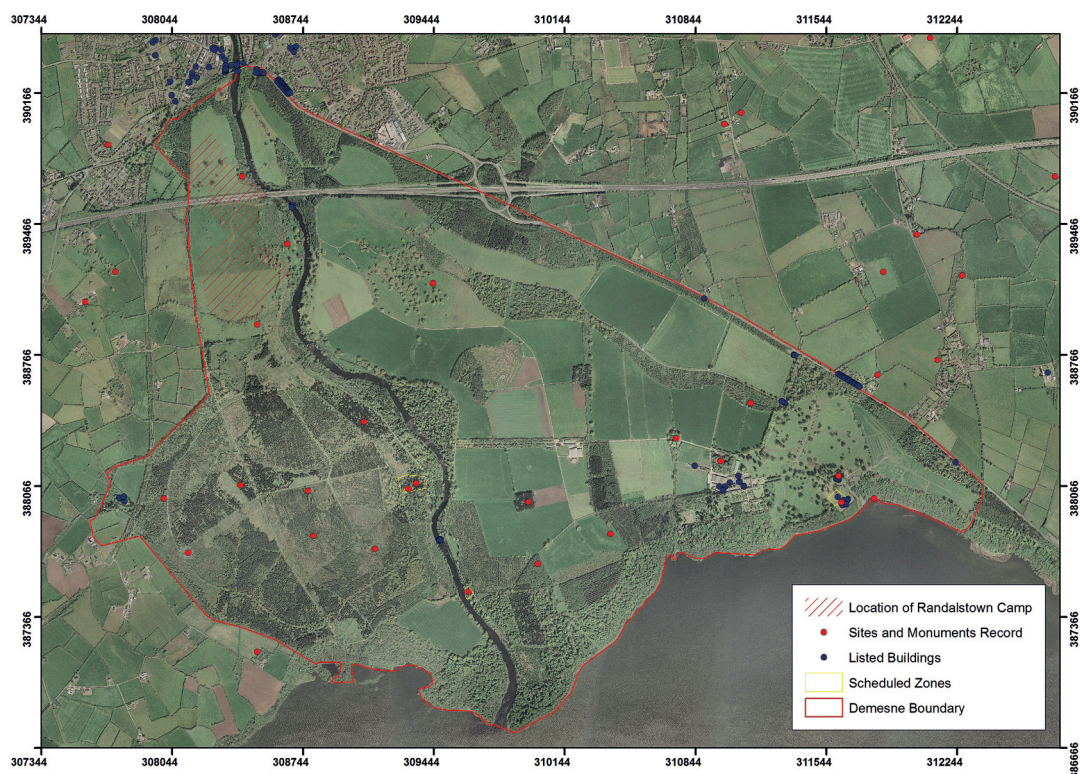
Archaeologists with an interest in World War I, like the wider archaeological community engaged in broad-scale landscape studies, have adopted the use of this technology as it provides, in many cases, a remarkable and considerably improved understanding of site topography.

Randalstown Case Study

INTRODUCTION

Randalstown camp is situated within Shane's Castle Park to the north of the former deer park in an area commonly known as Dunmore. It is currently characterised by open meadow and parkland. The historic parkland of Shane's Castle is recorded within the Register of Historic Parks, Gardens and Demesnes and a large area of it is designated as an Area of Special Scientific Interest (ASSI). The estate encompasses a range of historic features and listed buildings recorded within the Sites and Monuments Record (SMR) and Listed Buildings Register (Figure 6.2). It is worth noting that of the two recorded Defence Heritage Sites identified in the SMR neither dates to World War I. In fact up until now there has been no official record of the World War I training camp and its earthwork remains in our regional heritage inventory. The original Randalstown training camp was constructed in 1914 to house the 109th Infantry Brigade of the 36th Ulster Division. On the eve of World War I it was recognised that Finner Camp near Ballyshannon, County Donegal (where the 109th were initially located), would not be suitable to house large numbers of recruits, being as it was a tented camp formerly used to train troops for the Anglo-Boer Wars. As a result of untimely storms during October 1914 the majority of the Brigade were forced to re-pitch, living out the following two months in saturated conditions. The situation was untenable and in the absence of any permanent billets at Finner Camp the decision was taken to move the majority of the 109th Brigade to newly constructed quarters at Randalstown, County Antrim (Truesdale 2012: 22).

In 1914 Lord O'Neill of Shane's Castle made 80 acres of his estate at Dunmore available to the War Office for a new camp (to become known as the Randalstown Camp). Construction of the camp began in October 1914 and was completed in December, with the final formation of four sub-camps, namely: The Mount Camp, Dunmore Camp, Ridge Camp and Hollow Camp (Royal Engineers 1915). The transfer of the bulk of the 109th from Finner began that very same month and by January 1915 the 11th and 9th Inniskillings and 14th Rifles had been moved to Randalstown (the 10th Inniskillings remaining at Finner until May 1915) (Orr 2008: 63).

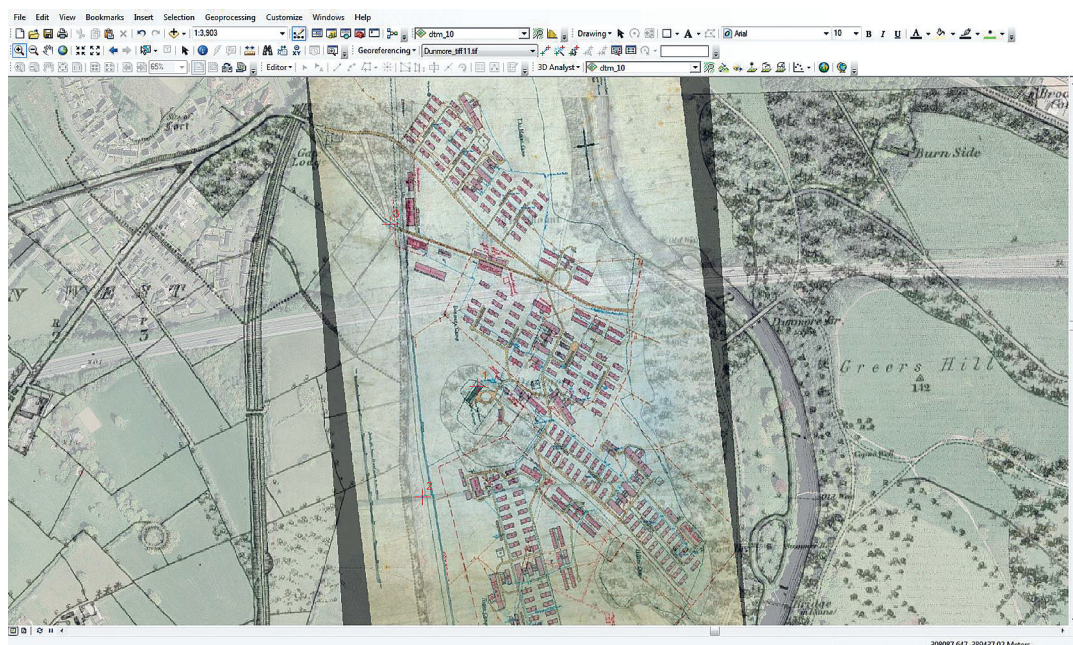


6.2 Distribution of Sites and Monuments Records (SMRs), Listed Buildings, Scheduled Zones and location of Randalstown Camp overlain on aerial orthophotograph. © Crown Copyright and authors

Private James McRoberts of the 14th Battalion writes of his arrival from Finner to Randalstown on Friday 8 January 1915, remarking on the relative comfort of the new huts they were to inhabit (Truesdale 2012: 23). The trained troops left for the front in July 1915 (Orr 2008: 64). From early 1916 the camp was redefined as a Command Depot for the rehabilitative training of soldiers too fit for convalescent camp, but not yet fit enough to be returned to active service (Baker 2013). From 1919 the camp was progressively dismantled and returned to pasture by 1951.

The location of the camp was, however, not forgotten in local memory and it is now one of a number of World War I landscapes in Ireland that are being studied as part of an ongoing multidisciplinary research programme based at QUB. Archaeological investigations by the authors have revealed earthwork traces of the camp in the modern landscape. When compared with a Royal Engineers map compiled in 1915, ALS data (in combination with aerial photographs) has allowed the layout of the camp to be re-established, while also helping to identify the location of specific elements such as barrack huts, stores, mess halls and officers' quarters.

The principal objective of the wider research programme is to generate a GIS inventory of these training sites and the associated practice trenches across Ireland, based on information from cartographic and documentary sources, remotely sensed data and fieldwork. For Shane's Castle ALS at 1 metre spatial



resolution is available and has recently been interrogated for its archaeological content by R. McNeary (2014a). The integration and georeferencing of a contemporary military plan of the camp with an ALS-derived Digital Terrain Model and aerial photographs has now enabled the camp to be 're-established' in the modern landscape and its broad layout plotted; thus allowing for its various elements – including barrack blocks, latrines, instruction halls and hospital blocks – to be located and analysed on the ground providing an appreciation of the camp construction and layout (Figure 6.3).

METHODOLOGY: COMBINING THE DOCUMENTS WITH THE GIS PROJECT

Investigation of the Randalstown Camp has been underpinned by the examination and integration of relevant existing archives and records which have helped to piece together a background to the development of the camp. Archives investigated included both published and unpublished documents available at various local and national museum repositories, such as The National Archives, Kew (TNA); examples include: war histories and narratives, such as formal correspondence between the War Office and government bodies, private diaries, photographs, chapters and official documents. In particular the authors have focused on the logistics and provision of suitable accommodation and training facilities as instructed by Major-General Scott-Moncrieff, the Director of Fortifications and Works in the Department of the Master-General of the Ordnance (Encyclopaedia Britannica 1922: 414). The construction and design of the camps was considered in an effort to identify the archaeological signature of camp features, such as barrack huts and trench systems as detailed in the official records (War Office 2008: 22–45).

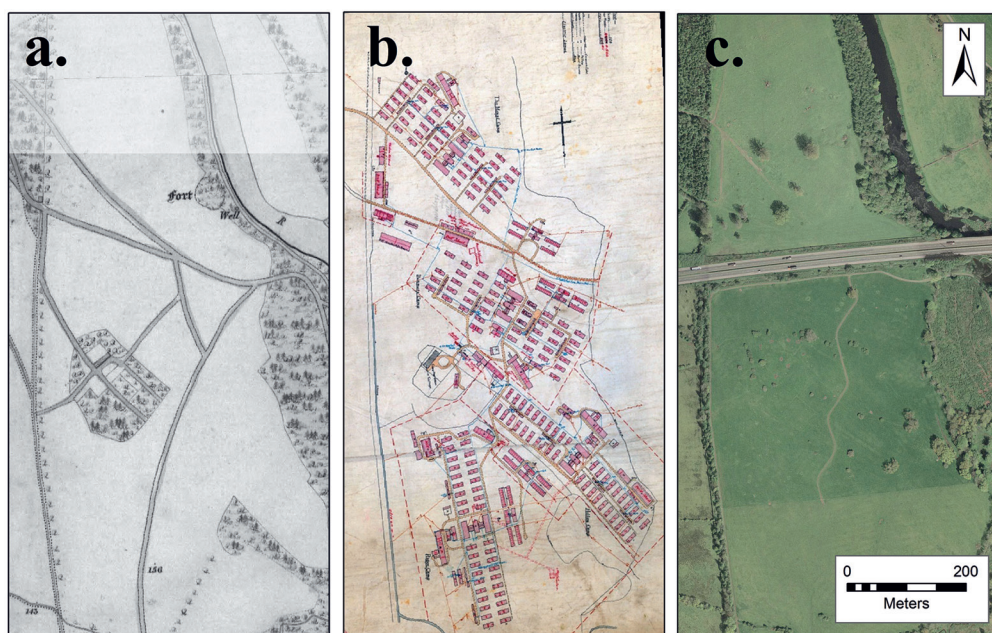
6.3 Screen-capture of georeferencing procedure for Royal Engineer plan of 1915 using common points taken from modern orthophotographs and georeferenced historic nineteenth-century maps.
© Crown Copyright and Royal Engineers (1915) Camp Plan - IE/MA/MPD/AS119287-002, Courtesy of www.militaryarchive.ie

The difficulty of trying to identify the remains of these camps on the ground is due to the fact that most were constructed of canvas and wood. As such, today often little remains on the landscape to tell a visitor where exactly a camp may have been located. At the core of this case study, however, is a set of exceptional maps drawn up by the Royal Engineers in 1915 depicting the new training camps as they were at that time. The maps are to a similar scale, operate on the same conventions and key, and are of such quality that it has been feasible to ascertain all the various elements that made up a typical training camp of the time – the cook-houses and dining rooms, the coal-yards and latrines, the practice yards and officers' messes, the barrack blocks, stables and so on; included amongst the camp plans is that of Randalstown. This plan of 1915 has been the principle vehicle for comparative analysis with the ALS data.

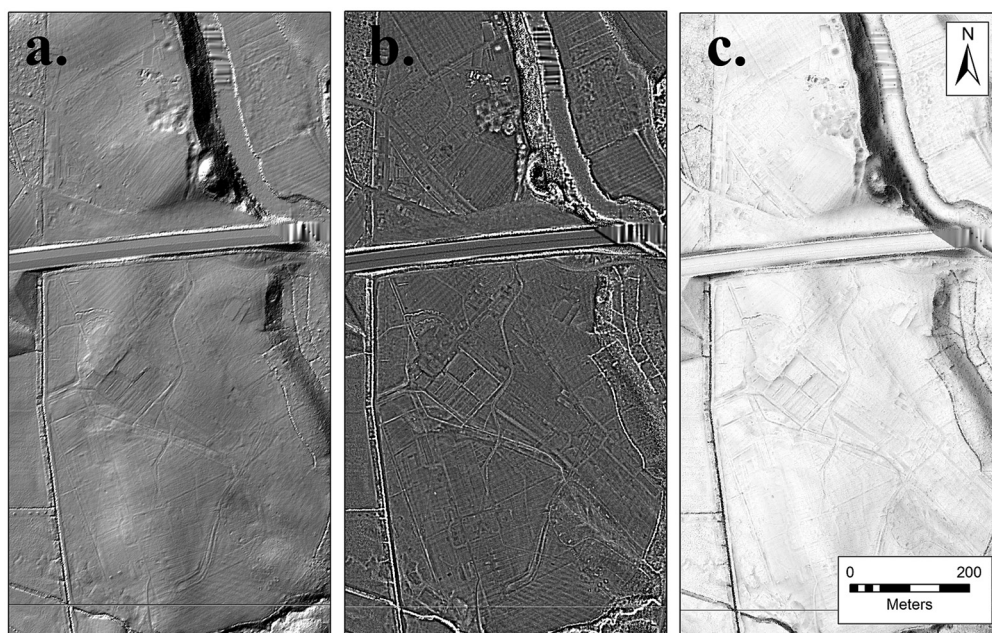
All available spatial data have been co-registered in a GIS project (ESRI ArcGIS v10.1), including the 1915 plan, contemporary OSNI® vector mapping (1:2,000 scale), OSNI® orthophotographs (Version 1: flown between March 2003 and July 2006; 25 centimetre resolution) and georeferenced nineteenth-century mapping (Figure 6.4).

The ALS data were originally collected by Furgo-BKS Ltd on behalf of the Rivers Agency in 2010 and whilst concentrating on the floodplain of the River Main fortuitously includes the site of the former camp. The data were supplied as a series of gridded tiles in ASCII file format of the 'last return' height data allowing for the creation of a Digital Terrain Model (DTM) or three-dimensional model of the un-vegetated ground surface. For the purpose of this study a number of now well established techniques for the visualisation and analysis of ALS data were used and facilitated by recent developments in stand-alone open-source ALS visualisation toolboxes, such as the Raster Visualisation Toolbox (RVT) developed by researchers at the Scientific Research Centre of the Slovenian Academy of Sciences and Arts (Kokalj et al. 2011) and the LiDAR-Visualisation Toolbox (LiVT– <http://sourceforge.net/projects/livt/>) developed by Ralf Hesse, both under the auspices of the Archaeolandscapes Europe project (Figure 6.5).

For this study the local relief visualisation technique in particular proved excellent for the identification of relict landscape features. In this case the local relief model (LRM) was derived by resampling the original DEM (1 metre) to a lower resolution of 7 metres (the trend DEM) which was then subtracted from the original DEM. This procedure separates local small-scale features from large-scale landscape forms (Štular et al. 2012: 3356). This visualisation was given context by comparing other raster visualisation techniques derived from the RVT toolbox (for an overview of these techniques see Devereux et al. 2008, Challis et al. 2011, Štular et al. 2012, Bennett et al. 2012), examination of vertical orthophotos, historic maps and the 1915 plan. 3D visualisations were also created in order to provide further perspective (Figure 6.6).



6.4 Location of Randalstown Camp as evidenced on: (a) OS 6-inch map of c. 1830s, (b) Royal Engineer plan of 1915, (c) aerial photograph (flown 2003–2006). © Crown Copyright and authors



6.5 Example of differing ALS visualisations: (a) standard hillshade, (b) local relief model (LRM), (c) Sky-View Factor. © Crown Copyright and authors

6.6 Integrating ALS topographic data, orthophotographs and the Royal Engineer plan to provide a 3D landscape view of the site of Randalstown Camp. © Crown Copyright, Royal Engineers (1915) Camp Plan - IE/MA/MPD/AS119287-002, Courtesy of www.militaryarchive.ie and authors

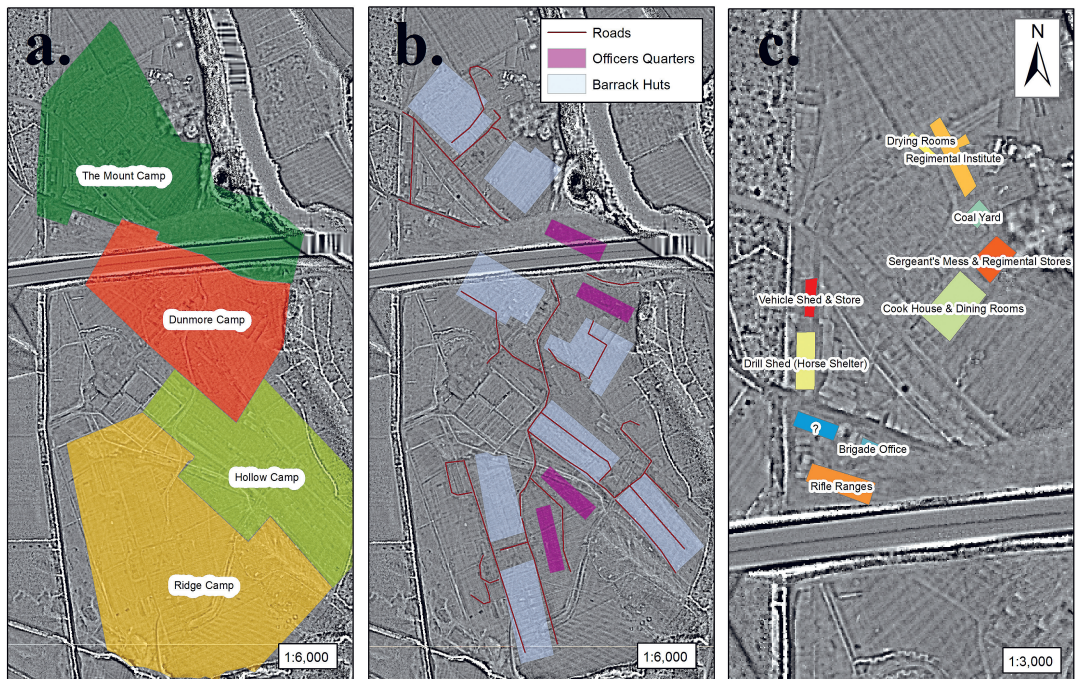


RESULTS

The pre- and post-war landscape at Randalstown, as depicted on nineteenth-century maps and post-war orthophotographs illustrates, in both instances, open parkland before and after the construction of the camp (Figure 6.4). However, this ALS-driven study has indicated a strong correlation between the features marked on the plan of 1915 and the earthwork remains visualised from the ALS data; and feature survival appears high in what remains largely a green-field site. The most obvious modern intrusion is the M22 motorway, constructed in the early 1970s, truncating the northern section of the camp.

The training camps were constructed to a standard plan with convenience of layout, good sanitary facilities and water supply being of primary concern. The barrack block huts commonly had wired electricity and were usually fitted with a single coal brazier for heating, a minimal offering in a structure so big. The camp would have had a shop, Post Office and Young Men's Christian Association (YMCA) building, as well as institutes for theoretical instruction in the 'art of war', and a number of recreational establishments and canteens. A church was also customarily established in the camp along with an infirmary and dispensary.

Randalstown camp was initially intended to accommodate four battalions of men and officers, in addition to the division's horses. These four divisions were located across four camps – Mount, Dunmore, Hollow and Ridge – the outlines and broad extents of which can be identified from the ALS (Figure 6.7a). Documents at The National Archives, Kew have provided drawings and photos of contemporary hut dimensions detailing the basic designs and construction of Armstrong hutting (TNA WO 161/117; WO163/44). Buildings such as barrack huts, quartermaster's stores and regimental offices were built to fit the 20 feet (6.1 metres) span design, with the men's dining rooms, cook-houses and regimental institutes constructed on the 28 feet (8.5 metres) span design.

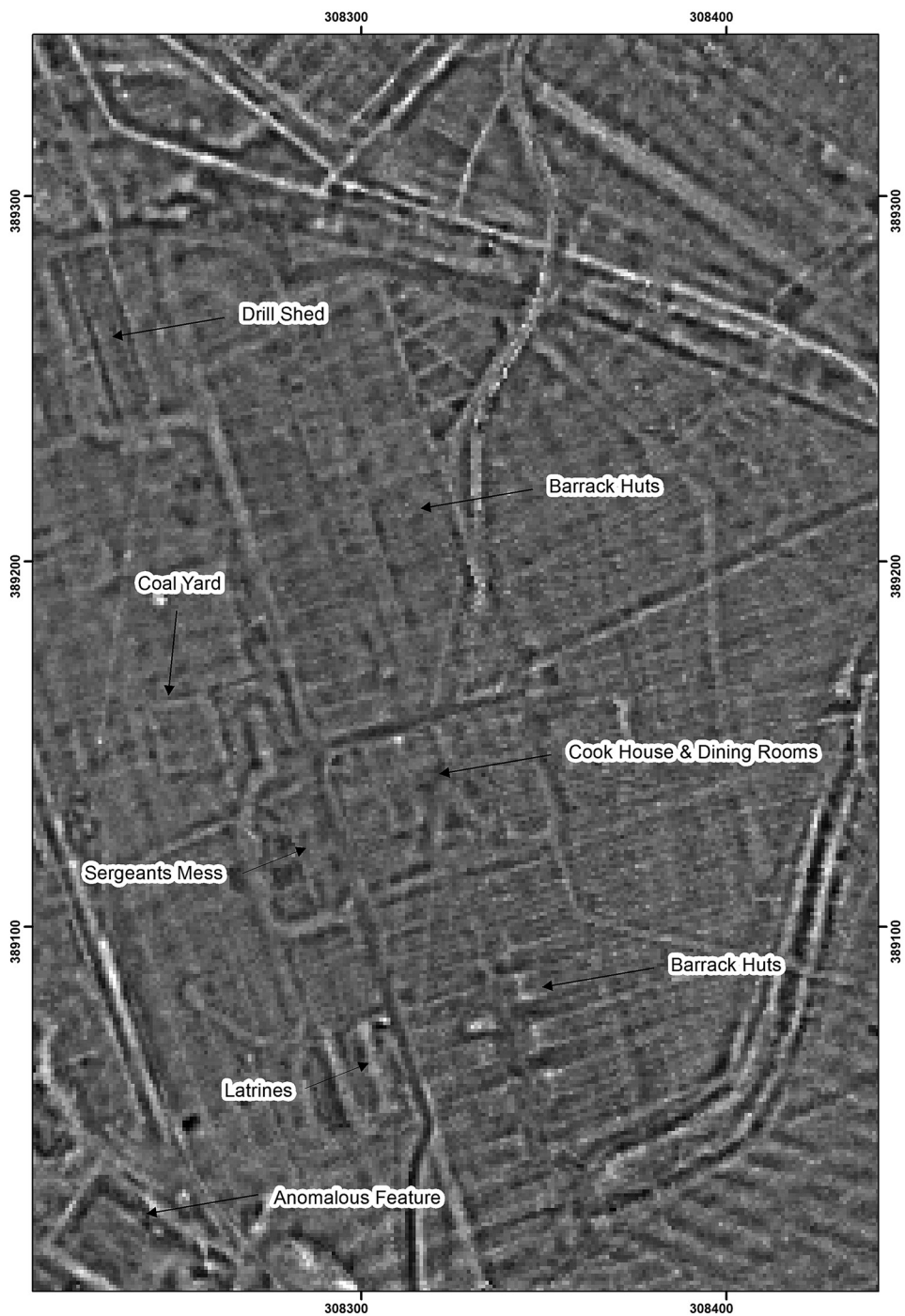


Officers' Quarters were constructed slightly larger at 90 feet (27.4 metres) by 30 feet (9.0 metres) (Simkins 2007: 234). The fabric of the huts reflects their temporary nature, originally built on a wooden framework with corrugated iron on the roof and external surfaces, with an internal asbestos lining as insulation. They were subsequently copied in large numbers and sent to the regional commands for mass production. The many ancillary buildings had similar construction but obvious differences and variations of design to suit their purpose; for example, coal stores, which consisted of an open yard and a wide entrance for a cart or vehicle access.

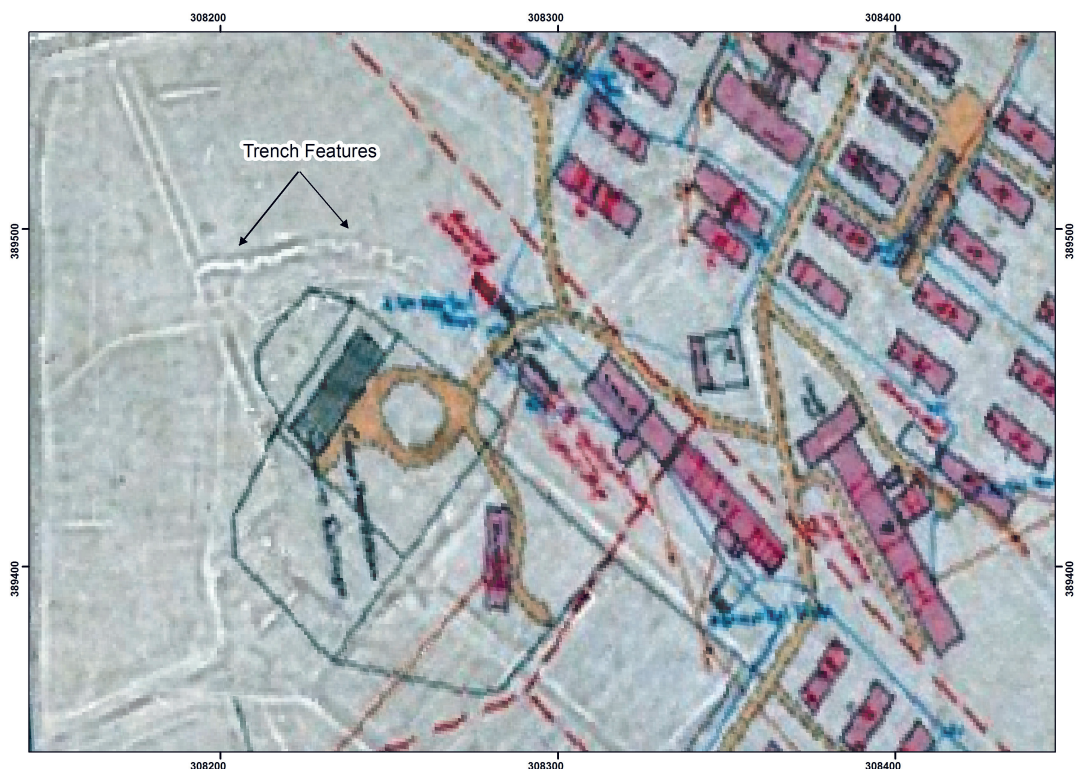
The constituent parts of each of the four camps can often be identified on the ALS from their specific configurations and dimensions and with direct reference to the georeferenced 1915 plan overlain as a transparency (see Figures 6.7, 6.8 and 6.9). Analysis of the setting of the identified structures reveals that most were located on levelled ground created by either an earthwork terrace or cut into the ground. Certain buildings, such as cookhouses and drying rooms and canteens, appear to have a deeper cut made for the foundations, thought to relate to the necessity for a more permanent floor surface such as large concrete floor slabs, necessary to support the massive cooking ranges and boilers, and as evidenced on recent fieldwork at Kilworth Camp in County Cork. These observations correspond with comparative studies (Simkins 2007: 15).

In addition it is noteworthy that not all identified features and structures of the Randalstown landscape visible in the ALS are documented on the 1915 plan. Features such as a crenelated section of trench (Figure 6.9)

6.7 Analysis of the combined data has allowed for the location of: (a) the four camp entities, and (b) and (c) the key elements within each of the camps. © Crown Copyright and authors



6.8 Analysis of the ALS data reveals that there are still earthwork signatures of a range of features recorded on the Royal Engineers plan, as well as additional anomalous features.
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are understood to relate directly to the camp and now need to be placed within the historic context of the site. The section of trench became apparent during data interrogation and appears to be of comparative construction and design to similar earthworks recently identified at other locations (for example, Ballykinler and Kilworth). The inner trench is about 45 metres in length and the outer trench about 80 metres, with a crenelated plan typical of World War I. These trenches were designed with the intention of reducing direct fire along the length of either the frontline or communication trenches in the event they were over-run, whilst also providing protective recesses (War Office 1921).

DISCUSSION OF TRENCH

The short curving section of crenelated trench is positioned just north of Dunmore Cottage and first assumptions were that this feature represented the vestiges of a larger system of training trenches. However, as the 1915 plan identifies Dunmore Cottage as the camp Post Office during 1914–18, questions must be asked. What is this doing at this particular location so close to the Post Office? Clearly it is not a practice trench as one would normally understand them and it is unlikely that one would have expected or anticipated a German attack at Randalstown; it is nonetheless perhaps possible that the earthworks were added to the infrastructure of the camp for genuine defensive reasons.

6.9 Detail of trench features as evidenced in an ALS data-derived local relief model (LRM) with georeferenced extract of Royal Engineer plan overlaid (50 per cent transparency). Source and © Crown Copyright, Royal Engineers (1915) Camp Plan - IE/MA/MPD/AS119287-002, Courtesy of www.militaryarchive.ie and authors

It is suggested that the trenches were laid out next to the Post Office as a defensive measure for a key element of the camp as a direct result of the unrest in Ireland during 1916. This may have occurred in the aftermath of the Easter Rising, during which time there was obvious escalation in security concerns at British military camps across the island. The Easter Rising was an armed insurrection in Ireland during Easter Week, 1916. The Rising was mounted by Irish republicans to end British rule, secede from the United Kingdom of Great Britain and Ireland and establish an independent Irish Republic.

FUTURE RESEARCH

The importance of the use of ALS to the current project is clearly evident. Nonetheless, value must continue to be placed on ground observation as this plays a key role in understanding the structure and evolution of these conflict landscapes, assisting in their management and creating awareness and interpretation of these sites for the wider public – a process key to the accurate understanding of any archaeological landscape (Shaw and Corns 2011: 82).

The results of this study support the future evaluation and management of the Randalstown camp, where it is hoped, through the combined efforts of government archaeological curators and the university sector, and in cooperation with the current landowners, a programme of terrestrial geophysical survey and ground-observation may be undertaken as an extension to the current desk-based project.

Areas of particular interest that might be targeted include the trench system at Dunmore Cottage, to ascertain exact dimensions and construction of the system, shedding further light on its positioning and function within the context of the overall camp, as well as retrieving potential artefacts in the form of trench furnishings or other related material culture.

Conclusions

The study at Randalstown and the wider project hope to shed light on the view of some existing narratives which depict the Irish Divisions as having been poorly trained and ill-prepared for war. The training facilities, such as that at Randalstown and those identified in the wider project, serve to highlight that in fact training for war in Ireland appears to have been as well thought out and prepared as at locations in England, Scotland and Wales. However, it is widely recognised that provision of adequate camps and training facilities alone did not necessarily mean complete mental and physical preparation of the troops in advance of the horrors they would have to endure at the front.

The research at Randalstown has also provided a methodology that can be applied at other locations, through the integration of non-invasive techniques, such as ALS, and contemporary plans and maps, and aerial photographs. This approach presents a significant opportunity for military historians and

archaeologists in Ireland to better understand the surviving remains of these camps, as well as informing the future management of these vulnerable and often overlooked aspects of Ireland's rich cultural landscape.

Acknowledgements

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References

- Baker, C. (2013) *The Long Long Trail: The British Army in the Great War, 1914–1918*. www.1914–1918.net (retrieved 2 February 2013).
- Bennett, R., K. Welham, R.A. Hill and A. Ford (2012) A Comparison of Visualisation Techniques for Models Created from Airborne Laser Scanned Data. *Archaeological Prospection* 19(1): 41–8.
- Brown, G. and D. Field (2013) Training for Trench Warfare: The Archaeological Evidence from Salisbury Plain. In N.J. Saunders and P. Cornish (eds) *Contested Objects: Material Memories of the Great War*, pp. 291–300. Milton Park: Routledge.
- Challis, K., P. Forlin and M. Kincey (2011) A Generic Toolkit for the Visualisation of Archaeological Features on Airborne Lidar Elevation Data. *Archaeological Prospection* 18(4): 279–89.
- Corns, A., J. Fenwick and R. Shaw (2008) More than Meets the Eye. *Archaeology Ireland* 22(3): 34–8.
- Corns, A. and R. Shaw (2009) High Resolution 3-Dimensional Documentation of Archaeological Monuments and Landscapes Using Airborne Lidar. *Journal of Cultural Heritage* 10(1): 72–7.
- (2013) Lidar and World Heritage Sites in Ireland: Why Was Such a Rich Data Source Gathered, How Is It Being Utilised, and What Lessons Have Been Learned? In R. Opitz and D.C. Cowley (eds) *Interpreting Archaeological Topography: Airborne Laser Scanning, 3D Data and Ground Observation*, pp. 146–60. Oxford: Oxbow Books.
- Council for British Archaeology (2015) *Home Front Legacy Project*. <http://www.livinglegacies1914–18.ac.uk/> (retrieved 20 April 2015).
- Davis, S., C. Brady, W. Megarry and K. Barton (2013) Lidar Survey in the Brú na Bóinne World Heritage Site. In R. Opitz and D.C. Cowley (eds) *Interpreting Archaeological Topography: Airborne Laser Scanning, 3D Data and Ground Observation*, pp. 223–37. Oxford: Oxbow Books.

- Devereux, B.J., G.S. Amable and P. Crow (2008) Visualisation of Lidar Terrain Models for Archaeological Feature Detection. *Antiquity* 82(316): 470–79.
- Encyclopaedia Britannica (1922) *A Dictionary of Arts, Sciences, Literature and General Information*. New York: University Press.
- Kokalj, Ž., K. Zakšek and K. Oštir (2011) Application of Sky-View Factor for the Visualization of Historic Landscape Features in Lidar-derived Relief Models. *Antiquity* 85(327): 263–73.
- Living Legacies 1914–18 (2015) *Living Legacies 1914–18 Project: From Past Conflict to Shared Future*. <http://www.livinglegacies1914-18.ac.uk/> (retrieved 20 April 2015).
- McCarthy, T. (2014) *An Appraisal of Military Trench Detection Using 2m LiDAR Data*. BSc edn. Unpublished Thesis. Dublin: Institute of Technology.
- McNeary, R. (2014a) Archaeological Feature Detection Using Airborne Laser Scanning at Shane's Castle Park, County Antrim. *Ulster Journal of Archaeology* 70: 111–25.
- (2014b) Applications of Airborne LiDAR for Cultural Heritage Management Initiatives in Northern Ireland. In M. Kammermans, M. Gojda and A. Posluschny (eds) *A Sense of the Past*, pp. 67–82. Oxford: Archaeopress.
- (2014c) Lidar Investigations of Knockdhu Promontory and Its Environs, County Antrim, Northern Ireland. *Archaeological Prospection* 21: 263–76.
- McOmish, D., D. Field, G. Brown, M. Corney, S. Crutchley and D. Cunliffe (2002) *The Field Archaeology of the Salisbury Plain Training Area*. Swindon: English Heritage.
- Megarry, W. and S. Davis (2013) Beyond the Bend: Remotely Sensed Data and Archaeological Site Prospection in the Boyne Valley, Ireland. In D.C. Comer and M.J. Harrower (eds) *Mapping Archaeological Landscapes from Space*, pp. 85–95. New York: Springer.
- Northern Ireland Environment Agency (2015) *Defence Heritage Project (NIEA) (DHP)*. <http://www.doeni.gov.uk/niea/defence-heritage-record.htm> (retrieved 20 April 2015).
- Orr, P. (2008) *The Road to the Somme: Men of the Ulster Division Tell Their Story*. Belfast: Blackstaff Press.
- Royal Engineers (1915) *Randalstown Camp*. IE/MA/MPD/AD119287–002 edn. www.militaryarchives.ie War Department.
- Shaw, R. and A. Corns (2011) High Resolution LiDAR Specifically for Archaeology: Are We Fully Exploiting This Valuable Resource. In D.C. Cowley (ed.) *Remote Sensing for Archaeological Heritage Management*. EAC Occasional Paper No. 5 / Occasional Publication of the Aerial Archaeology Research Group No. 3, pp. 77–86. Brussels: Europae Archaeologia Consilium.
- Shell, C. and C. Roughley (2004) Exploring the Loughcrew Landscape: A New Airborne Approach. *Archaeology Ireland* 18: 22–5.
- Simkins, P. (2007) *Kitchener's Army: The Raising of the New Armies 1914–1916*. UK: Pen & Sword Military.
- Štular, B., Z. Kokalj, K. Ostir and L. Nuninger (2012) Visualization of Lidar-derived Relief Models for Detection of Archaeological Features. *Journal of Archaeological Science* 39(11): 3354–60.
- Truesdale, D. (ed.) (2012) *'Young Citizen Old Soldier': From Boyhood in Antrim to Hell on the Somme: The Journal of Rifleman James McRoberts, 14th Battalion Royal Irish Rifles, January 1915 – April 1917*. England: Helion and Company.

- War Office (1921) *Manual of Field Works (All Arms) (Provisional)* 2011. Reprint edn. Naval & Military Press: General Staff, War Office. London: HM Stationary.
- (2008) *Manual of Field Engineering*, reprinted 1914, Chapter V. Earthworks. In S. Bull (ed.) *An Officer's Manual of the Western Front, 1914–1918*, pp. 22–45. London: Conway.



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Aerial Perspectives on Archaeological Landscapes: The Anzac/Ariburnu Battlefields, Gallipoli, Turkey

Jessie Birkett-Rees

Abstract

This chapter examines the archaeological landscape of the Gallipoli peninsula, with a focus on the remains of the 1915 conflict within the modern commemorative landscape. The cultural landscape of the Gallipoli battlefields provide complex evidence from the past, drawn together here within a spatial framework that articulates the substantial archaeological contribution to this contextual study of past human conflict. This recent research uses historical spatial data (specifically, military maps and plans from the World War I era) in conjunction with archaeological survey and GIS to investigate the formation and preservation of archaeological features in the Anzac area on the Gallipoli peninsula, concentrating on the area known as Lone Pine/Kanlı Sirt.

Keywords: Gallipoli, World War I, Dardanelles, Anzac, Lone Pine, Turkey.

Introduction

The cultural landscapes of former battlefields provide us with complex evidence from the past. The breadth and depth of content in this volume alone demonstrates this, whilst also highlighting that these landscapes of conflict exist in the present; change in appearance and interpretation is part of the human legacy of sites of conflict. This chapter investigates the major modifications in the landscape of the northern battlefields on the Gallipoli peninsula. Otherwise known as the Anzac, or Ariburnu area, this was the sector in which most Australian and New Zealand Army Corps (ANZAC) forces were positioned during the World War I conflict at Gallipoli in 1915. This is also the area that was granted in perpetuity as a memorial landscape to the Allied and Ottoman war dead and an open cemetery for the many

missing (Treaty of Lausanne 1923). The development and preservation of the battlefield landscape is examined from above, through the use of plan-view maps and aerial photographs from the World War I era, integrated with the results of surface archaeological field survey undertaken in 2010–14.

The Northern Battlefields of Gallipoli

The Gallipoli peninsula has a long history as a contested landscape, positioned beside the strategic waterway of the Dardanelles. In antiquity, Xerxes and his army of Persians entered Europe via the Gallipoli peninsula and it is from the peninsula that Alexander the Great later crossed the Dardanelles to begin his conquest of Asia (Herodotus 7.33–34, Arrian 1.11.3–6). The action of the Trojan, Persian and Peloponnesian wars took place in this area and, more recently, the peninsula was part of imperial contests between the Seljuks, Byzantines, Venetians and Ottomans. But for many people today the Gallipoli peninsula is associated with one particular conflict: the attempt by the Allies to force the Dardanelles in 1915.

This battle lasted nine months, from the naval conflict in March and the landing of troops on the peninsula in April 1915 to the retreat of the Allied forces in December. Industrial warfare changed the landscape of the peninsula, physically and symbolically, and claimed the lives of some 130,000 soldiers, the majority of whose bodies remain on the peninsula. This was a multi-ethnic conflict between the expansive armies of the Ottoman Empire and the Allies, yet it has come to hold a particularly significant place within the national narratives of Turkey, Australia and New Zealand.

The military history of the 1915 campaign on land and sea has generated abundant literature, but little research has been done on the archaeological record of the Gallipoli battlefields. In 2010, with a view to the centenary of the World War I conflict at Gallipoli, the governments of Australia, New Zealand and Turkey launched a collaborative historical and archaeological survey to document the northern battlefields within the Anzac/Arıburnu area. This project, the Joint Historical and Archaeological Survey (JHAS), resulted from discussions between all three nations and an Australian Government Senate Committee Report (2005), which recommended a survey of the heritage features in this part of the Gallipoli Peace Park. The project, which completed its fifth and final field season in September 2014, is an interdisciplinary collaboration between historians and archaeologists, and is the first to receive a permit to conduct archaeological surveys within the Gallipoli battlefields.

In this official sense, the most recent predecessor to the JHAS was the Australian Historical Mission (AHM) in 1919, instigated by Charles Bean, the Australian war correspondent who landed at Gallipoli with the Anzac troops in April 1915 and later became Australia's official war historian (Bean 1948). Bean's motivation in revisiting the Gallipoli battlefields was to solve several 'riddles' of the eight-month land campaign, for which he was accompanied by

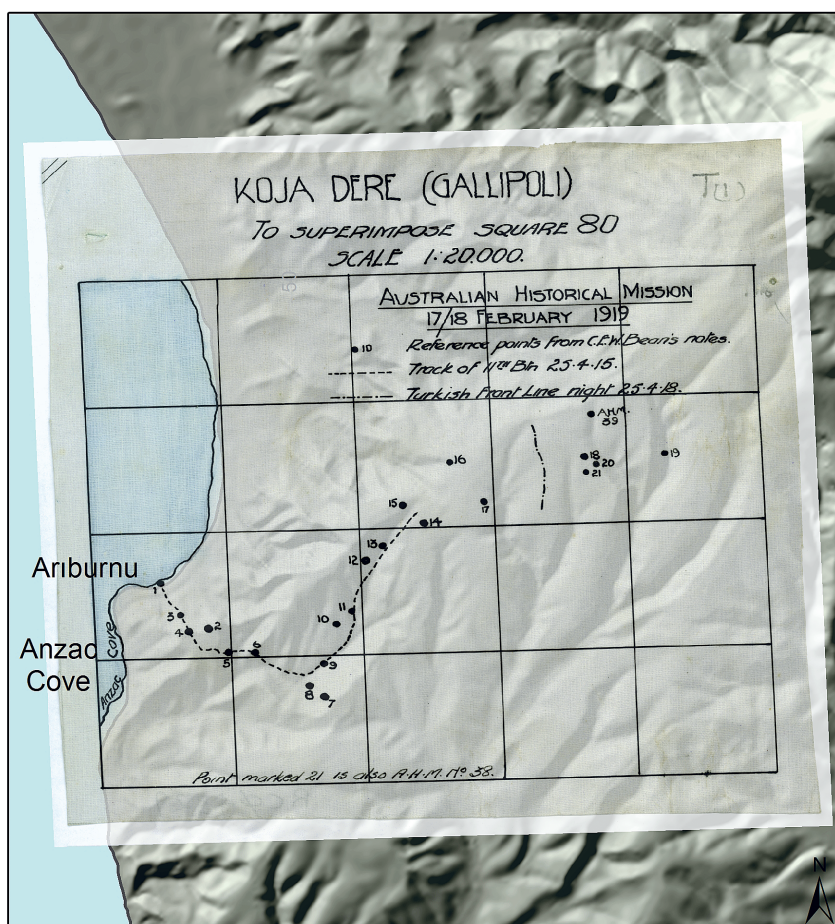
a multidisciplinary team including the artist George Lambert, photographer Hubert Wilkins, cartographer Herbert Buchanan and several veterans of the Gallipoli campaign. An Ottoman perspective was provided by Major Zeki Bey, a battalion commander at Ariburnu who was able to assist Bean for several days.

The AHM spent 11 days in the Anzac/Ariburnu area recording the locations of artefacts and attempting to trace particular wartime events. Whilst he covered an impressive amount of ground, Bean's agenda was not to systematically survey the surviving features of the battlefield. Rather, he attempted to position particular people, units and events with accuracy in the terrain, with the goal of informing his official history of the conflict and providing information for future interpretation of the battlefield. For Bean, the physical setting of the campaign, the dramatic and complex landscape of Gallipoli, was a central aspect of the story of Anzac and needed to be recorded and understood. In addition to the paintings and photographs made by Lambert and Wilkins, various positions that were significant to Bean's interpretation of the battlefield, such as the inland route taken by parties of Anzac soldiers on 25 April 1915, were mapped using the gridded 1:20,000 wartime maps as a base (for example [Figure 7.1](#)). By mapping the locations of artefacts and specific events, Bean and his team sought to add context and meaning to the wartime events by linking them with the material record in the landscape. The JHAS has taken a more systematic approach to the battlefields, employing modern archaeological survey methods, but shares Bean's concern with providing a landscape context within which to interpret the remnant features of the battlefield.

Bean's conviction that the landscape was a key element in the historical interpretation of Gallipoli led him to recommend reserving an area he called the 'old Anzac' position. This is the part of the Ariburnu battlefields that was held by the Allies between April and August 1915, before the changes in territory that resulted from the August Offensive (Bean 1948: 89). In 1921, in preparation for the peace talks with Turkey, the Imperial (later Commonwealth) War Graves Commission (I/CWGC) produced a map that defined this area. A smaller-scale version of this map was included as Map No. 3 in the Treaty of Lausanne (1923), which formalised the Anzac area and provides for CWGC access to this open cemetery (Part V, Section II, Article 129). The JHAS fieldwork was conducted within the boundaries of this 'Anzac area' ([Figure 7.2](#)). The location of several of the markers of the Anzac area had been lost over the last 94 years, but our survey has relocated all but one.

The JHAS project has several goals, centred on recording and investigating earthworks and artefacts from 1915 within the context of the pre-war landscape and the post-war commemorative features. Here I discuss the Anzac area at the scale of landscape, focusing on the earthworks and memorials that changed the shape of the peninsula, without reference to the substantial database of artefacts from 1915 recorded during the JHAS fieldwork. In concentrating on the structural remains of the battlefield, I intend to highlight the ways in which the recent survey results and the flexible framework of a Geographical

7.1 A georeferenced sketch map produced by the Australian Historical Mission (1919), indicating the route taken by the 11th Battalion during the Anzac landings on 25 April 1915. The points marked along the route refer to events charted by Charles Bean, author of the *Official History of Australia in the War of 1914–1918*. Source Australian War Memorial and author



Original map: 'Koja Dere, Gallipoli'

Australian Historical Mission, 1919.

RC04329 Australian War Memorial collections.

Key: dashed line marking the track of the 11th Battalion, 25.4.1915

0 0.25 0.5 1 Kilometre

Information System (GIS) have afforded us a broader range of spatial and temporal perspectives on the Gallipoli peninsula. An important part of the JHAS research has been the development of a GIS as a means for integrating digitised archival data with the results of modern differential GPS (DGPS) controlled survey. GIS offer a means to combine data captured at a range of spatial scales, and the capacity to move between the key scales of artefact, site and landscape. The layered structure of GIS lends itself to mapping, displaying and investigating the spatial relationships between the records of different periods at Gallipoli. By examining war-era aerial photographs and maps, which offer views of the battlefield from above, we can investigate changes in this landscape over time. This is helping us understand how the extensive battlefield features developed over the months of 1915, their preservation over the years of the last century, and their place within the commemorative landscape of today.

A Pivotal Geography

The popular understanding of Anzac in Australia and New Zealand centres on the beaches and the sandstone cliffs above them. The broader battlefield consists of a much more varied landscape, structured by northeast-southwest trending ridges and deeply incised gullies. This is rugged and complex terrain. The few names given to these ridges and valleys before the war reflect the rural character of the peninsula, such as Ağıl Dere (Sheep-pen Valley), Serçe Tepesi (Sparrow Hill) and Asmak Dere (Vine Valley). The conflict in 1915 saw many new names spread across the battlefield, articulating strategic positions and tactical concerns (400 Plateau, Shrapnel Valley, Bomba Sirt), and expressing the horror of the war (the Valley of Despair, Bloody Angle, Korku Dere) (Ashmead-Bartlett 1915, Broadbent 2010).

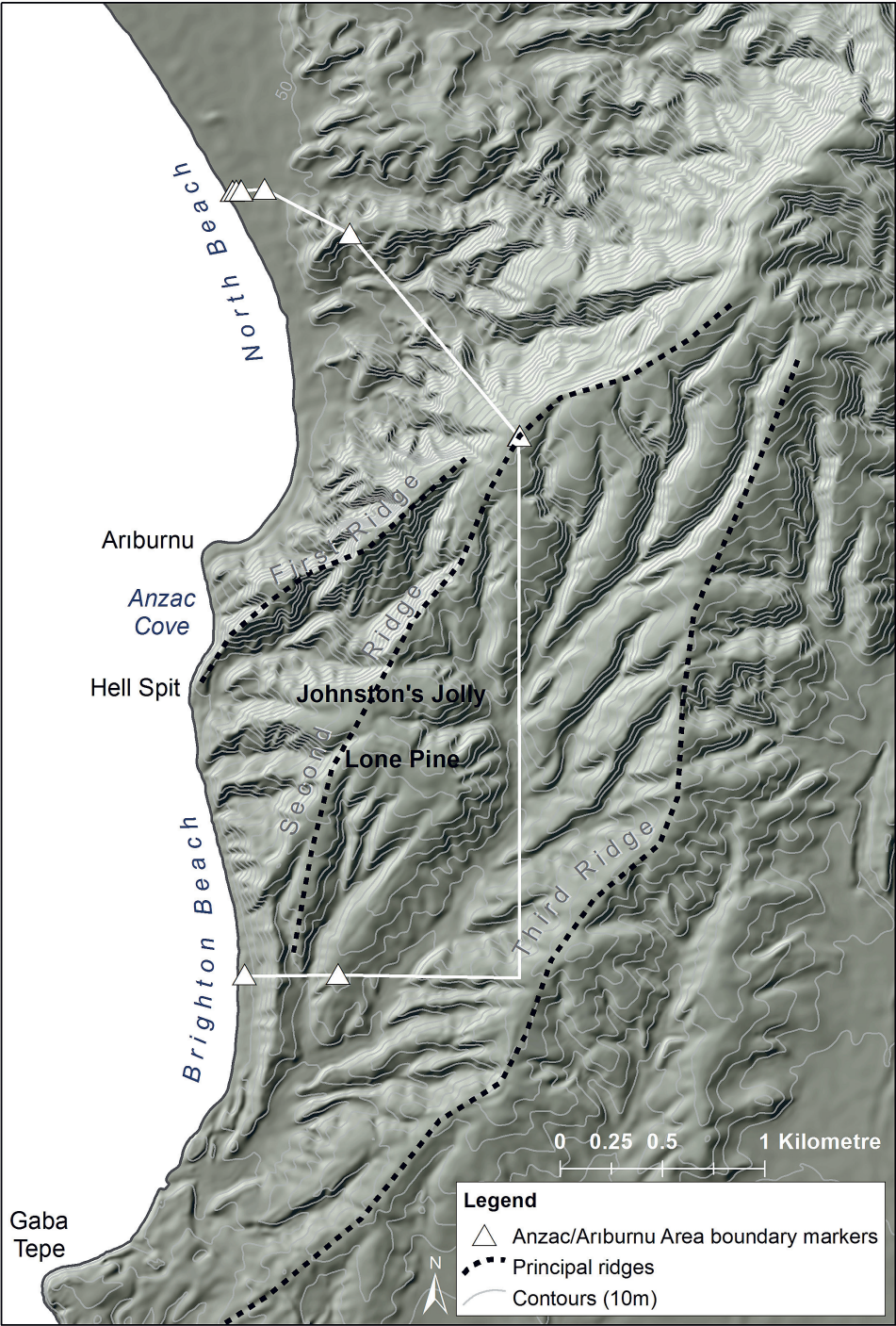
The names given in 1915 to the prominent ridges of the Anzac area provide structure for historical descriptions of the Gallipoli battlefields and for the work of the JHAS. Research has concentrated on the Second Ridge, located between the First Ridge and the long Third Ridge, which extends from coastal Gaba Tepe to the heights of Chunuk Bair (Figure 7.2). Contemplating the battlefield landscape in 1919, Bean explains the naming of the ridgelines and the creation of the frontline:

Looking back to the early days of the expedition, when this, the third ridge from our landing beach on the Aegean Sea, had been the objective set for most of our troops on the first morning, we thought of it as the Third Ridge. But it was never ours; from the first morning the front had ebbed back on to the top of the second ridge from our landing place. (Bean 1948: 47)

Gallipoli was a largely static conflict, punctuated by infrequent, intense battles for small pieces of ground; the frontlines were fairly well established by the first week of May 1915 and did not alter substantially until the August Offensive (6–9 August). The Anzacs took the First Ridge and the Turks held the Third, with much of the frontline along the Second Ridge, making it one of the most fiercely contested parts of the peninsula. The JHAS is investigating the whole of the Anzac area but the Second Ridge offers Ottoman and Allied features in equal measure, allowing us to investigate the material remains of both sides of the conflict. The iconic sites of Lone Pine/Kanlı Sirt, Quinn's Post/Bomba Sirt, the Nek/Cesaret Tepe and the major Turkish memorial to the 57th Regiment are located along this ridgeline.

Although the geography of the Anzac area is rugged and the vegetation hardy, giving an impression of endurance, Gallipoli is a physically, culturally and politically sensitive landscape. The evolving commemorative landscape sees personal experiences mix with evolving national narratives, as monuments old and new variously intersect the remnant trenches, terraces and tunnels that characterise the 1915 battlefield. The battlefield has been framed as a contested landscape in the present (Scates 2007, 2008, Ziino 2012), but the role of the Anzac area as a peaceful resting place for the war dead has endured since the Armistice.

The 'Anzac Area' at Gallipoli



7.2 The Anzac/Ariburnu Area on the Gallipoli peninsula. © author

The appearance and connotations of the Anzac area have certainly changed over the last century but this landscape still contains some of the least-disturbed World War I earthworks in the world. The special status of the area was reinforced with the establishment of the Gallipoli Peninsula Historical National Park in 1973 and the United Nations' listing of the Park as a Protected Area in 1997.

The preservation of features of the battlefield is due in large part to the thick vegetation, precipitous hillsides and generally rugged geography of the site: beautiful, dramatic, but decidedly uninviting to farmers. In the years immediately before the conflict the landscape of the Gallipoli peninsula was agricultural but the Anzac area was too hilly for any but the most intrepid livestock. This part of the battlefield grew with 'wild scrub' (Bean 1948: 325), cultivated only in the more easterly valleys that give onto the open plain (for example Map of Gallipoli, Sheet 2, AWM RC04360). The rough topography of the Anzac area meant that this ground remained largely untouched after the war. This is in contrast to the other battlefields on the peninsula, at Cape Helles and the Suvla Bay region, and to the former battlefields of the Western Front in which valuable fields and pasture between the cemeteries and memorials were gradually restored and resettled after 1918. Even with the increasing number of visitors to Gallipoli, tourism is firmly focused on the easily accessible cemeteries, memorials and beaches, with few people venturing off the maintained paths within the park. The convoluted terrain of the Anzac area, the later reservation of land within the National Park and the vegetation which has since covered much of the former battlefield have contributed to the relatively undisturbed nature of the Anzac area.

Modern Survey Methodology

The Anzac area is well preserved but no longer resembles the barren landscape captured in photographs and descriptions from 1915. Native Mediterranean vegetation has reclaimed the site, along with intentional planting of pines on the Second Ridge. The dense scrub which now covers much of the former battlefield, together with the unusually rough terrain of the Anzac area, meant that conventional intensive archaeological survey techniques had to be modified. Impenetrable thickets and eroded scarps rendered traditional grid-based field survey impossible, so the JHAS instead operated a feature-based survey, following trench lines to delineate their full extent and recording all associated artefacts and features within the transect (Sagona et al. 2011). Our fieldwork at Gallipoli was entirely non-invasive; the only subsurface investigation consisted of Ground Penetrating Radar (GPR) survey of the Second Ridge Road between Quinn's Post and Lone Pine to identify potential tunnel locations.

Detailed field notes and photographs were taken during the survey, and accurate locations of trench lines, tunnels, dugouts, artefacts and other features were recorded using DGPS. Recording precise spatial information

on the location of artefacts and features allows us to integrate the record of material remains on the battlefield with historical documents from the war era, including military maps and aerial photographs. The goals of the survey were not to locate particular military features or to follow historic maps in the field, rather to record visible remains within the former battlefield. The survey has assembled this record of visible features, with comparisons between features depicted in Ottoman and Allied historical maps, plans and aerial photographs within a GIS after fieldwork. In this manner the JHAS recorded the wartime and pre-war archaeological record within the battlefield area, and is now able to examine earthworks and artefact distributions, investigate rates of preservation, and study the relationships between the pre-war, wartime and modern commemorative features.

Lone Pine/Kanlı Sirt on the Second Ridge

The JHAS has pieced together the remaining record of some important sectors of the battlefield, including sections of the frontlines, communication trenches, dugouts and support areas. At Lone Pine, an area significant to both the Ottoman and Allied armies, the intersection of pre-war, wartime and post-war commemorative landscapes is particularly striking when viewed and analysed from above. Lone Pine is a strategic point in the landscape with commanding views of the peninsula and the Aegean Sea. The area was initially known to the Anzacs as '400 Plateau', on the basis of their joint operations maps, part of a wide and level area high on the Second Ridge. For several days in April 1915 control of this area moved back and forth between the Anzacs and the Turkish troops, with the Anzac hold on the plateau not consolidated until 10 August. The northern part of this plateau became known as Johnston's Jolly and the southern part as Lone Pine ([Figure 7.2](#)).

Little of the wartime network of trenches is visible in aerial views of the landscape today due to the dense vegetation covering the Anzac area. Airborne Laser Scanning, which would likely prove productive in this area, was not within the scope of the JHAS project. But we are able to reposition the trench lines within the landscape using historic maps and aerial photographs. Pre-war maps indicate that this was an area of low scrub with no distinctive features; by September 1915, trench maps reveal a landscape dramatically transformed by networks of trenches extending from the beach along the ridge to Lone Pine (for example AWM published collections RC04179). Maps of the 400 Plateau from September 1915 show the significant changes made to the landscape during the August Offensive, the last Allied push in their attempt to break the stalemate of trench warfare by moving eastward into the Turkish lines. On [Figure 7.3](#) one such trench map is overlaid on the present-day landscape, with the old Anzac line marked in black, the new line shown in blue and the Turkish line in green. The large 'Plateau Sap', which can be seen running roughly east-west, eventually connected the old and new Allied trenches.

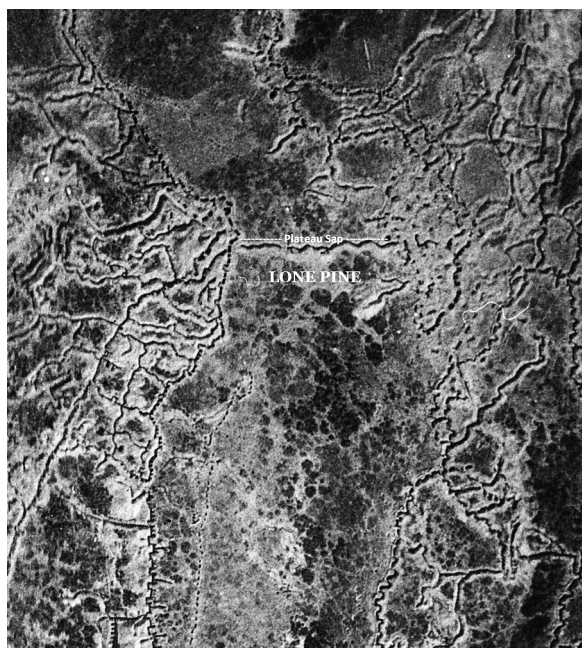


Original image sources: Pleiades satellite and RC02227 Australian War Memorial collections.

0 25 50 100 Metres

7.3 A georeferenced historic map of the Lone Pine earthworks (September 1915) overlaid on the modern landscape. The historic map shows the old Anzac frontline to the east (in black), the new frontline established during the August Offensive (in blue) and the new Turkish frontline (in green). Dashed lines indicate subterranean works, including an extensive 'apron' tunnel system.

Source author and Australian War Memorial



7.4 Lone Pine and 400 Plateau, part of an aerial photograph, taken on 27 October 1915, by the RNAS and restored by the Australian War Memorial. The full image can be viewed online (AWM collection number RC04275). The faint lines of tunnels can be seen running parallel to the old Anzac frontline. Source Australian War Memorial

A series of ‘apron’ tunnels, marked as dotted lines, can be seen projecting from the old Anzac frontline toward the Turkish front. These tunnels were later connected by transverse tunnels, forming an ‘apron’ beyond the frontline, which could then be opened to form a new frontline (Bean 1935: 260). The map ([Figure 7.3](#)) shows the Allied side of the conflict but the Ottomans were also taking the battle below the surface and tunnelling into the plateau. This plan-view of the battlefield overlain on satellite imagery of the modern landscape provides an effective visual display (see also [Chapter 15](#)) of the often complex spatial relationships between wartime earthworks, memorial sites constructed in the 1920s and the modern infrastructure of the Peace Park.

Aerial photographs have also proved to be a productive resource for archaeological research into conflict landscapes (Stichelbaut et al. 2009, Stichelbaut 2006), capable of providing insight into the extent of the wartime features at Gallipoli and enabling meaningful comparisons with the remnant battlefield features visible today. There are few aerial photographs of the Gallipoli battlefield compared to the vast archives for the Western Front (see also [Chapters 1](#) and [17](#)). This difference is due partly to the shorter duration of the conflict at Gallipoli and in part to the novelty of the technology in 1915. The capabilities for capturing aerial photographs and the techniques for transforming them into serviceable maps were much improved in the later years of the war (MacLeod 1919, Jones 1928). Even so, we have several significant aerial images of the Anzac area which help us to examine the form of the battlefield. [Figure 7.4](#) shows the Lone Pine area on 27 October 1915, with the Plateau Sap and the pre- and post-August frontlines clearly distinguished against the barren earth. The pitted lines of opened tunnels are also visible; these can be identified with specific, numbered tunnels in [Figure 7.5](#), which brings the georeferenced trench map together with the orthorectified aerial images.

In this manner, the war-era maps and aerial photographs can provide us with insight into the development of trench networks, inscribed into the ridges and gullies of the Anzac area. Although the frontlines at Gallipoli shifted very little during eight-months of trench warfare, the battlefield landscape was dynamic; it was modified daily by subterranean works and explosives from above and below the surface. In order to investigate the preservation of features from 1915 we must refer to records of the final form of the battlefield.



Original aerial photographs: AWM RC04274,
RC04275, RC04276, RC04311
Australian War Memorial Collections.

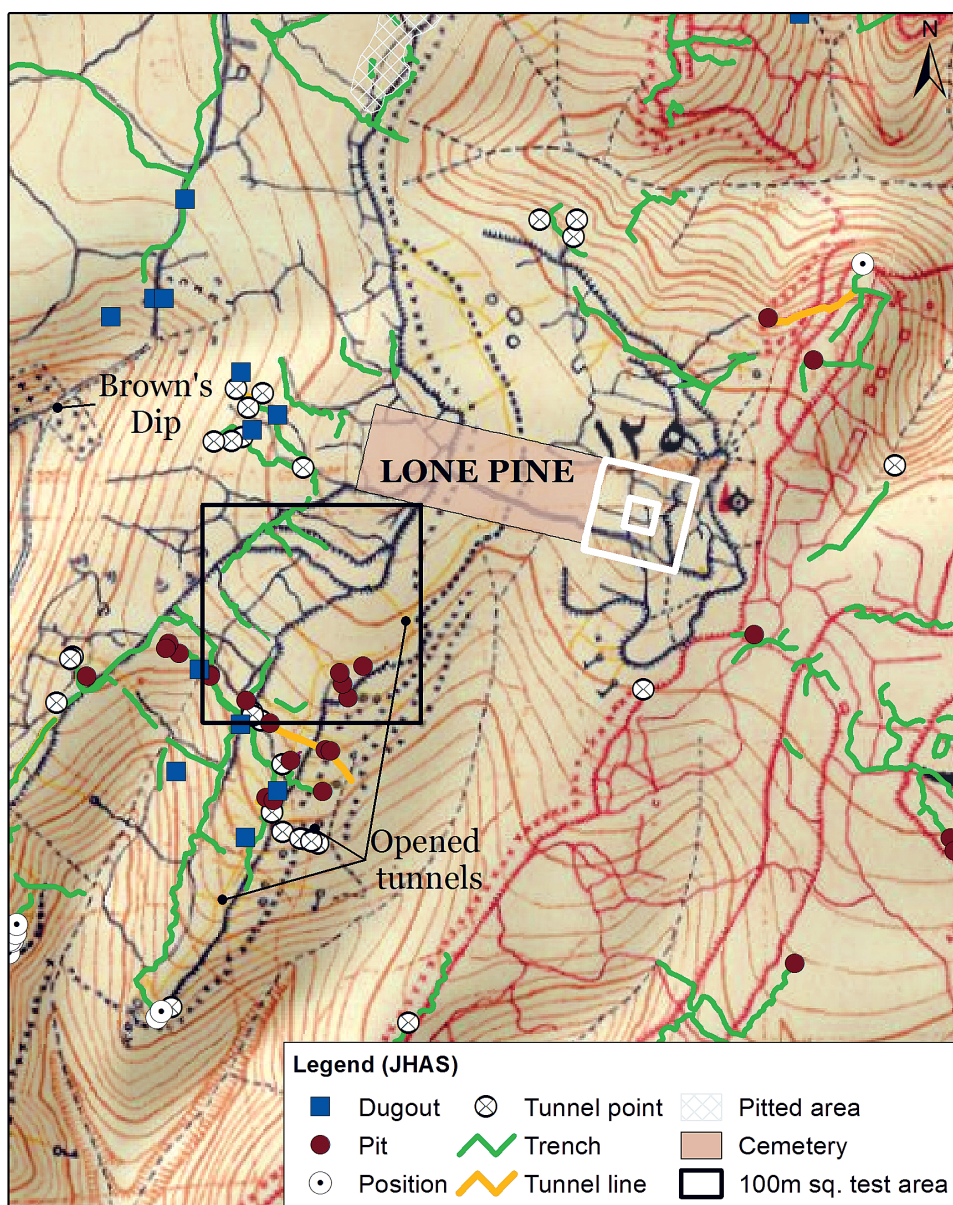
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7.5 The Lone Pine area, showing the relationship between the georeferenced map shown in Figure 7.3 and the aerial imagery captured on 27 October 1915.
Source author and Australian War Memorial

Shortly after the Allied evacuation of the peninsula in December of 1915, Turkish surveyors and cartographers under the direction of Brigadier General Mehmet Şevki Paşa produced a significant series of maps, covering the peninsula from its southern tip at Cape Helles to Suvla Bay in the north. The Turkish 1:25,000 operations maps were enlarged to a scale of 1:5,000 and onto this were mapped the abandoned trench lines, cemeteries and encampments of both sides of the conflict (Wood 1918). This produced an invaluable record of the battlefield as it was in late 1915 and 1916, and reveals the Ottoman recognition of the significance of the battlefield landscape. Sheet 17 of this series was one of the resources used by Charles Bean's survey team in 1919 and has also proved useful to the JHAS (a digitised version of Sheet 17 is available to view in the Australian War Memorial collections: RC03163). Comparisons between the location and extent of features shown on the Şevki Paşa map series and the remnant features traced in fieldwork of 2010–14 provide an indication of the rate of preservation in the silt and sand of the Anzac area (Figure 7.6). Within a 100 square metre area covering part of the old Anzac frontline at Lone Pine, the JHAS recorded 263 metres of trench lines and only 4 metres of slumped tunnels. Examining this same area on the Şevki Paşa map, there are 725 metres of trench lines recorded and 208 metres of tunnels. This should not be taken to be representative of the entire battlefield, which comprises several different environmental and historical contexts, but allows us to say that some 36 per cent of trenches and 28 per cent of all 1915 earthworks at Lone Pine remain visible today.

One objective in consulting aerial imagery and plan-view depictions of the Anzac area is to identify change over time, so that we might better articulate the different layers of the cultural landscape. The record of place names, field boundaries, farmsteads and the locations of roads and streams shown on the Şevki Paşa maps also provide valuable information on the context of the battlefield in 1915–16. As well as preserving a record of the peninsula in 1915–16, the Şevki Paşa map has recorded wartime features that were later removed. The original location of the two Brown's Dip cemeteries (west of Lone Pine) is clearly shown; this battlefield cemetery would later be removed as part of the construction of the post-war landscape, with the dead reburied at the Lone Pine cemetery. Whereas the existence of the Brown's Dip cemeteries is known in the records of the IWGC, the Şevki Paşa map has also been used to help locate 18 Ottoman battlefield cemeteries, for which there were no other records known (Worldbulletin 2013, see also Büyüksaraç et al. 2013).

The construction of the Lone Pine cemetery and memorial to the missing in the 1920s substantially changed this part of the battlefield, reshaping the landscape from one of conflict into one of formal, international remembrance. During the construction of the monument and cemetery in 1923, the land was filled and levelled, and stone embankments and drainage channels constructed (Figure 7.7). Overlaying the spatial record of the JHAS survey with the Şevki Paşa map (Figure 7.6), or with the aerial photographs and war-era maps, makes explicit the complex relationship between the surviving trenches,



Original map (underlay): WO 301/444/01

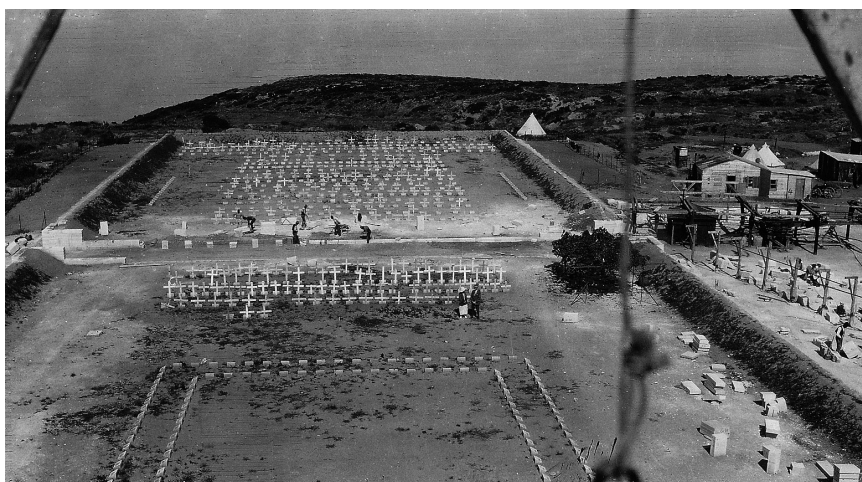
National Archives, London.

Key: Anzac trenches in blue; Turkish trenches in red; all tunnels in yellow.

7.6 Showing the results of the JHAS survey superimposed on a map produced by Brigadier General Mehmet Şevki Paşa's cartographic team in 1916. This is part of Sheet 17 and shows the Lone Pine area. The area now occupied by the Lone Pine cemetery and memorial is also shown, providing a visual indication of the relationship between the wartime features and the commemorative landscape. The 100 m² area to the southwest of the cemetery serves as an initial test area for evaluating preservation and visibility of 1915 earthworks over time.

Source author and National Archives London

7.7 A photograph taken in 1923 during the construction of the Lone Pine cemetery and memorial. Note the filling and levelling of the ground and the creation of an embankment wall. Source CWGC archives, Maidenhead



tunnels and positions of 1915, the post-war structures and the more recent roads and car parks. As changes of varying scale and consequence continue to be made to the Gallipoli battlefields, there is a certain value in articulating the initial transformation from battlefield to commemorative site, and in delineating what remains of the 1915 features today.

Conclusions

Aerial perspectives on the Anzac area at Gallipoli, in mapped and photographic form, provide useful insights into the development of the battlefields at the scale of landscape. These documents assist archaeological investigations of landscapes of conflict, particularly in understanding site formation processes and evaluating present-day preservation. Integrating the spatial records of historic and modern landscapes within a GIS platform provides powerful, quantitative analytical capabilities and allows us to more easily visualise the multi-layered nature of conflict landscapes. This approach also goes some way toward mitigating the static impression that maps, photographs or archaeological survey records can convey when considered in isolation. Archaeological landscapes are dynamic artefacts in their own right, in terms of the processes active in their development and the changing ideas invested in them. It is here that we may begin to encounter some limitations of 'remote' perspectives alone; a crucial aspect to our understanding of the development of conflict landscapes is that at the human scale. The bird's-eye views provided by maps, aerial photographs and satellite imagery exist on a different plane, and are selective, in many ways highly sanitised, views of the landscape (Saunders 2009: 31). After the August Offensive, Sergeant Cyril Lawrence wrote: 'The undergrowth has been cut down, like mown hay, simply stalks left standing, by the rifle fire, whilst the earth itself appears just as though one had taken a huge rake and scratched it all over' (East 1981: 68).

Lawrence's view of destruction in the landscape is quite different to the detached perspective afforded from above. The same could be said of the experience of the memorial landscape today, which continues to provoke intense and emotive responses.

The archive of maps, plans and photographs is of most use when brought together with the results of fieldwork. This allows us to link aerial perspectives to the material record present in the landscape today and so provide contextual detail for both the historical documents and the archaeological record. At Lone Pine/Kanlı Sirt, the commemorative landscape of the Anzac area has reshaped the battlefield, intersecting and obscuring parts of the war-era features. The changing nature of human interaction with this significant landscape is highlighted by examining the dramatic transformation of the Anzac area, from sparsely settled rural ridgelines to entrenched landscape of conflict, to post-war commemorative construction site, to modern Peace Park.

What Gallipoli signifies to Turkish, Australian and New Zealand audiences has changed over time and continues to evolve. Although the modern Gallipoli landscape bears little resemblance to records and accounts of its appearance in 1915, the landscape that developed during the battle is well preserved beneath the scrub and between the cemetery lawns. In attempting to understand the human landscape in battlefields and at sites of conflict, the aerial perspective provides one of several valuable sources. Bringing this perspective together with historical descriptions and archaeological records in a multi-disciplinary approach offers a productive method for examining the largest cultural artefact of World War I: the landscape.

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References

- Arrian, with an English translation by E. Iliff Robson (1967) *Anabasis Alexandri*, Volume I. Cambridge, MA: Harvard University Press.
- Ashmead-Bartlett, E. (1915) 'Telegrams', transcribed by Peter Mayo for the State Library of New South Wales. Sydney: State Library of New South Wales.
- Australian Government Senate Committee Report (2005) *Matters Relating to the Gallipoli Peninsula*. Canberra: Commonwealth of Australia, xxvii–viii; Recommendation 3.
- Bean, C.E.W. (1935) *The Story of ANZAC*, Volume II. Sydney: Angus and Robertson.
- (1948) *Gallipoli Mission*. Canberra: Australian War Memorial.
- Broadbent, H. (2010) Gallipoli's Place Names. *Placenames Australia Magazine*, March.
- Büyüksaraç, A., C. Çağlar Yalçın, Y. Levent Ekinci, A. Demirci and M. Ali Yücel (2013) Geophysical Investigations at Agadere Cemetery, Gallipoli Peninsula, NW Turkey. *Australian Journal of Forensic Sciences* 46(1): 111–23.
- East, R. (ed.) (1981) *The Gallipoli Diary of Sergeant Lawrence of the Australian Engineers*. Melbourne: Melbourne University Press.
- Herodotus, with an English translation by A.D. Godley (1920) *Histories*. Cambridge, MA: Harvard University Press.
- Jones, H.A. (1928) *The War in the Air: Being the Story of the Part Played in the Great War by the Royal Air Force*, Volume II. Oxford: Clarendon Press.
- MacLeod, M.N. (1919) Mapping from Air Photographs. *The Geographical Journal* 53(6): 382–96.
- Sagona, A., M. Atabay, R. Reid, I. McGibbon, C. Mackie, M. Erat and J. Birkett-Rees (2011) The ANZAC (Arburnu) Battlefield: New Perspectives and Methodologies in History and Archaeology. *Australian Historical Studies* 42: 313–37.
- Saunders, N.J. (2009) Ulysses' Gaze: The Panoptic Premise in Aerial Photography and Great War Archaeology. In B. Stichelbaut, J. Bourgeois, N.J. Saunders and P. Chielens (eds) *Images of Conflict: Military Aerial Photography and Archaeology*, pp. 27–40. Newcastle-upon-Tyne: Cambridge Scholars Publishing.
- Scates, B. (2007) The First Casualty of War: A Reply to McKenna's and Ward's 'Gallipoli Pilgrimage and Sentimental Nationalism'. *Australian Historical Studies* 38(130): 312–21.
- (2008) Memorialising Gallipoli: Manufacturing Memory at Anzac. *Public History Review* 15: 47–59.
- Stichelbaut, B. (2006) The Application of First World War Aerial Photography to Archaeology: The Belgian Images. *Antiquity* 80(307): 161–72.
- Stichelbaut, B., J. Bourgeois, N.J. Saunders and P. Chielens (eds) (2009) *Images of Conflict: Military Aerial Photography and Archaeology*. Newcastle-upon-Tyne: Cambridge Scholars Publishing.
- Treaty of Lausanne (1923) *Republic of Turkey, Ministry of Foreign Affairs, Multilateral Conventions, Lausanne Peace Treaty, Part V: Miscellaneous Provisions*. http://www.mfa.gov.tr/lausanne-peace-treaty-part-v-miscellaneous-provisions-1_prisoners-of-war.en.mfa (retrieved 9 January 2015).
- Wood, Col. (1918). *Report on the Turkish Survey Department*, 11/12/1918. WO 301/47. London: The National Archives.

Worldbulletin (2013) 18 Soldier Cemeteries Discovered in Çanakkale, *Worldbulletin Newsdesk*, 13 March 2013. <http://www.worldbulletin.net/servisler/haberYazdir/104702/haber> (retrieved 10 January 2015).

Ziino, B. (2012) We Are Talking about Gallipoli After All: Contested Narratives, Contested Ownership and the Gallipoli Peninsula. In M. Gegner and B. Ziino (eds) *Heritage of War*, pp. 142–59. Abingdon: Routledge.



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Landscapes of Death and Suffering: Archaeology of Conflict Landscapes of the Upper Soča Valley, Slovenia

Dimitrij Mlekuž, Uroš Košir and Matija Črešnar

Abstract

The Soča (Isonzo) Front was the southernmost section of an almost 600 kilometre long frontline between the Austro-Hungarian Empire and Kingdom of Italy. One third of the Soča frontline ran over the Upper Soča Valley and Julian Alps; large parts of this conflict landscape are located in a remote and inaccessible terrain – either covered by dense forest, or located in the mountains. This chapter focuses on the survey of the conflict landscape in the Upper Soča Valley, Slovenia. Conflict landscapes are often multi-temporal, where features that were used, reused and modified during conflicts forming a complex palimpsest of traces. In order to understand the relations between individual features, structures and the surrounding landscape, an integrated approach using remote sensing methods (Airborne Laser Scanning) and field surveys was employed. This allowed us to approach the landscape as a whole. The landscape was not just a setting, nor was it an artefact resulting from human activity. Instead, the landscape played an active role in the lives of people during conflict. The closer perspective offered by field surveying brings additional insights to the vast quantity of remains, their preservation and post-abandonment processes, and the attrition of remains both in the harsh environmental conditions and from scavenging and relic hunting. Integrating remote sensing and field surveys allow us to approach a hostile landscape shaped by forces bigger than a single human life, but also to interrogate material practices that struggle to preserve the integrity and identity of bodies thrown into conflict.

Keywords: Soča (Isonzo) Front, Mount Rombon, Slovenia, World War I, Airborne Laser Scanning, conflict landscapes.

Introduction

Conflict landscapes are not a group of isolated defensive structures, but rather a complex system of the traces of conflict with their own histories of formation, development and processes of change. Conflict landscapes are often multi-temporal, and they include features used, reused and modified in different periods, creating a complex palimpsest of traces (Carman 2013).

In contrast to architectural and topographic surveys, which are often concentrated on individual structures and their immediate surroundings, remote sensing methods are non-selective. They treat whole landscapes in the same way, allowing us to understand the relations between individual features and structures and their position within the wider landscape. Visualisations of Airborne Laser Scanning (ALS) data, supplemented by field survey and ground observation reveal complex relations between defensive structures from different periods, traces of conflict and difficult topography. In this way fortifications, defensive structures and other traces of conflicts can be understood as an integral part of a landscape. Remote sensing within this integrative approach can contribute to a deeper understanding of the layered conflict landscapes.

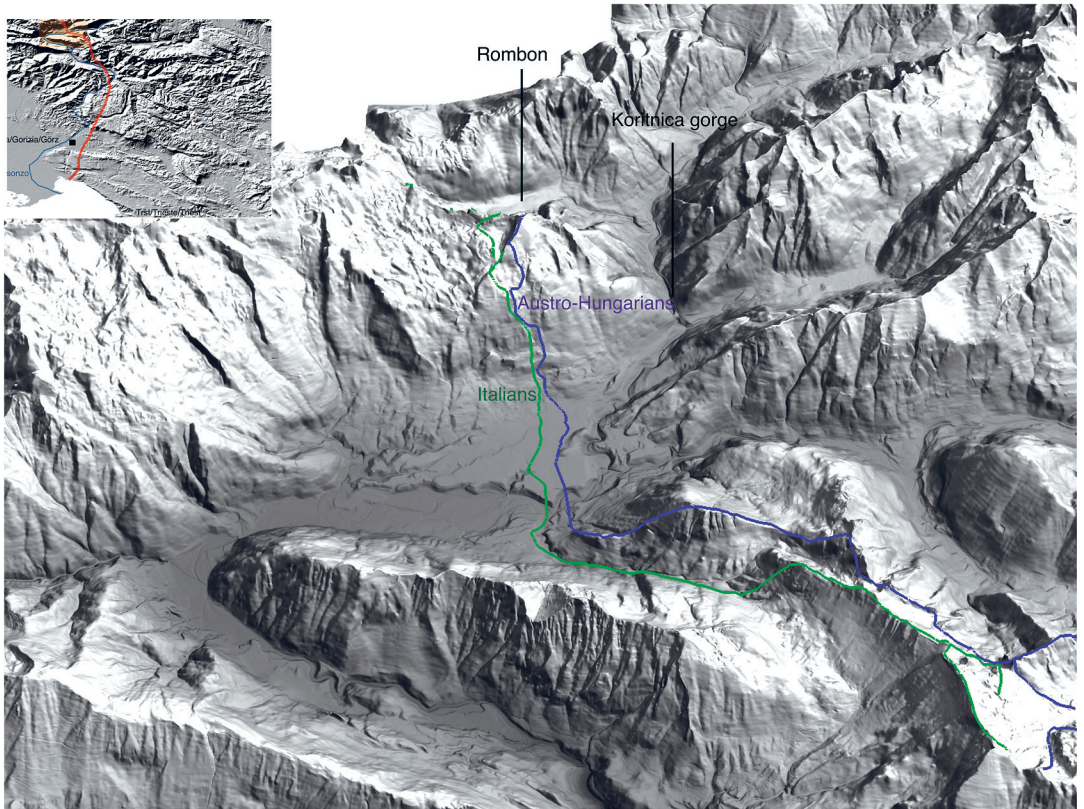
To demonstrate this approach in an inaccessible landscape we surveyed the multi-layered conflict landscape around Bovec, in the Upper Soča Valley, Slovenia. This landscape provides challenges to archaeological research as it is located in a remote and inaccessible terrain, sometimes covered by dense forest, and located high in the mountains.

The peaks above the Upper Soča Valley represent the highest battlefields on the Soča (Isonzo) Front during World War I. The conflict left many traces in the landscape. The survey allows us to examine how modern industrialised warfare was imposed on a topographically diverse landscape like the high mountain peaks of the Julian Alps (see also Košir 2012, Saunders et al. 2013). Further, it allows study of how these traces can be recorded and understood using archaeological approaches.

Brief Historical Background

No conflict takes place in an empty space but instead is rooted in a history of past conflicts. Conflict landscapes are often layered, and there are several such layers of historical palimpsest creating a landscape of conflict in the Upper Soča Valley.

The Upper Soča Valley – better known by its Italian name the Isonzo Valley including the Bovec basin – holds a strategic position as a transitional zone between the Northern Adriatic and the Alps. The key strategic location along this corridor is the narrow Koritnica gorge, which lies between the slopes of Mounts Rombon and Izgora, just above Bovec in the direction of the Predel Pass towards Tarvisio and Carinthia (Figure 8.1).



Isolated finds suggest this was already an important place in the prehistoric and Roman periods. The earliest documentary evidence for defensive structures dates to the second half of the fifteenth century when a Venetian fortification was built above the deep gorge as a defence against Ottoman incursions (Simić 1998: 28). In 1509 it failed to perform its functions fully in the first war between the Venetians and the Habsburgs, which saw the fort rebuilt in stone and reinforced. The fortress underwent several modifications until the end of eighteenth century, when it was destroyed during the Napoleonic wars in 1797 (Klavora 2000: 41, 47, Simić 2005: 106, Klavora 2007). The present-day appearance of Fort Kluže dates to 1882, when a new rock-cut road was built along the western bank above the Koritnica River (Klavora 2000: 47). The fortification of this strategic area was supplemented by the 'upper' fortress, called Fort Hermann, built on a rocky ridge over the gorge and completed in 1900 (Simić 2005: 139–41).

On 24 May 1915, with the Italian attack on Austria-Hungary, the war extended to the Soča Valley. The aim of the Italian Army was to penetrate towards the Villach basin and Tarvisio, and then towards the Ljubljana basin before moving on into the centre of the Austro-Hungarian Empire (Klavora 2000: 67). The Austro-Hungarian military authorities proposed the defence should rest on the mountain peaks and ridges above the Soča, as they were

8.1 The Bovec basin with the location of the Koritnica gorge and the frontline during World War I shown. © Institute for the Protection of Cultural Heritage of Slovenia, Centre for Preventive Archaeology (IPCHS CPA)

easier to defend. The Austro-Hungarians therefore withdrew from the old Austro-Hungarian-Italian border to this new line.

The Soča Front was the southernmost section of the 600 km long frontline, which ran from the Swiss-Italian-Austrian border, across the Dolomites, the Carnian Alps and the Julian Alps (Simić 1998: 11). The Soča Front comprises the 90 km long section that ran along the Soča River and across mountain tops and ridges from Rombon, then across the Krn mountain range and south to the Karst plateau and thence to the Adriatic. Except for the so-called Gorizia and Tolmin bridgeheads, the defensive positions followed the left bank of the Soča River. During the 29 months of warfare, from May 1915 through October 1917, 12 offensives were fought here. Eleven of them were launched by the Italians, with the last one attempted by the Austro-Hungarian and German army. Fighting took place mainly in mountainous landscapes and karst regions.

Koritnica gorge proved to be one of the key points in the conflict. Both fortresses witnessed the battles of World War I, but met different fates. Fort Hermann was destroyed during artillery barrages launched in the first months of conflict, but the Italian artillery could not reach Fort Kluže, which was protected by the slopes of Mount Rombon (Simić 2005: 249–76, Galić 2007: 19).

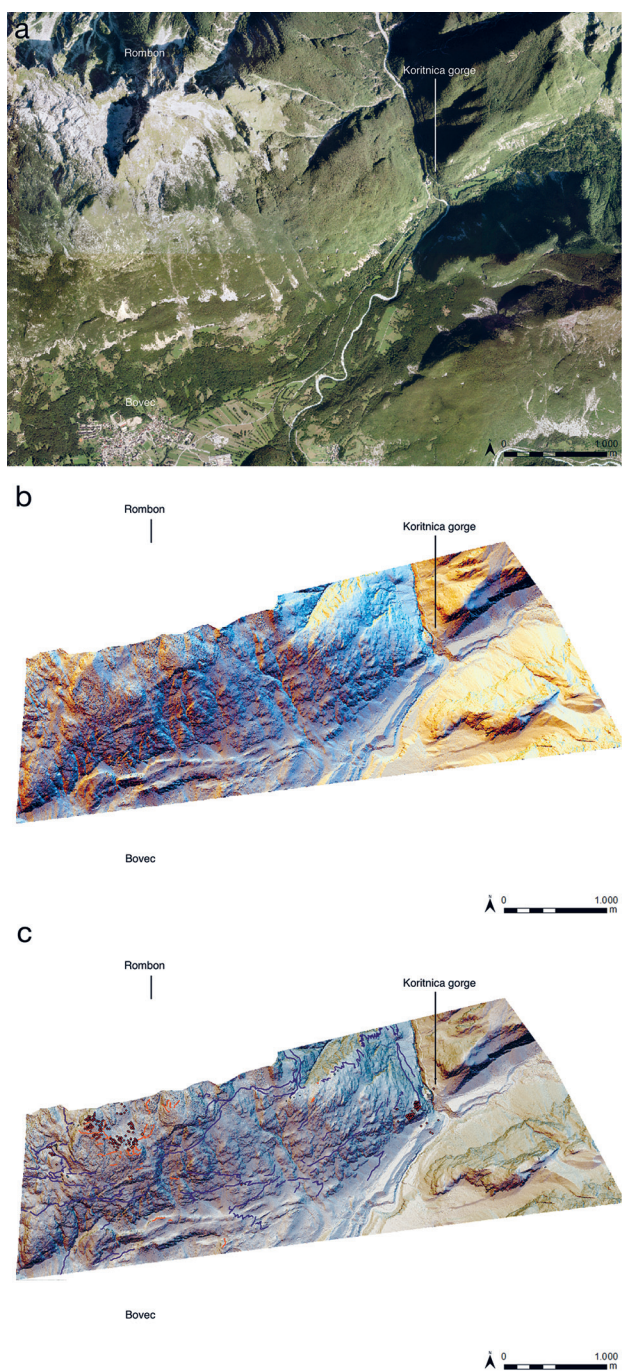
The fighting shifted to the peaks and slopes above the Koritnica gorge. This is a jagged and hostile mountain landscape, located above the tree line, and marked by surface landforms typical for high altitude karst: solution runnels, limestone pavements, perched funnel dolines, karst depressions and other karst phenomena. Lack of surface water during summer and deep snow cover during winter creates an inhospitable, rugged and isolated stone desert.

After the war with Italy broke out, Austro-Hungarian troops started building positions on Mount Rombon. After the initial Italian conquest of Čuklja peak (1,767 metres) below Rombon, the Austro-Hungarian positions were built extending from the peak of Rombon over the small summit of Mrtvaška glava (1,583 metres) or Totenkuppe 1 ('Dead man's head') towards Ravelnik hill in the Bovec basin. The positions stayed more or less fixed there until the Twelfth Battle of the Isonzo in October 1917 when combined Austro-Hungarian and German forces broke through the Italian lines. The high alpine battlefield on Rombon was abandoned, and became a memorial landscape and a target for battlefield scavengers.

The Kluže fortress was also used in World War II, when its appearance was once again partly altered. As the road was being widened and the bridge reconstructed during administration by the Allies, the defence rampart with its entrance portal was removed (Simić 2005: 301–3).

ALS Survey

An Airborne Laser Scanning (Opitz 2013) survey was centred on the Koritnica gorge, a narrow bottleneck along the Koritnica River on the corridor towards the Predel Pass. An area of 5 square kilometres was surveyed around Koritnica gorge and the slopes of Mount Rombon above the Bovec basin (Figure 8.2).



8.2 Aerial view of the study area (a), multiple hillshaded DTM from ALS data of the study area (b) and identified features (c) with trenches (orange), pathways (purple), shell holes (red) and building platforms (blue). © Institute for the Protection of Cultural Heritage of Slovenia, Centre for Preventive Archaeology (IPCHS CPA)

The main aim of the ALS survey was to provide a detailed and precise 3D map of this conflict landscape, to better understand the relationships between different layers of the landscape palimpsest (Mlekuž 2013). This included the recording of the fortifications that controlled the approach through Koritnica gorge and the traces of conflicts in its surroundings, mainly the World War I battlefield on Mount Rombon.

The ALS survey was conducted from April to June 2013. The area proved to be extremely challenging for ALS surveying due to the huge differences in altitude (between 400 and 1,900 metres), very rugged topography, steep slopes, dense vegetation – especially mountain pine (*Krummholz*) above the tree line – and the long duration of snow cover at higher altitudes. Flights had to be repeated several times in order to capture the ground between snow cover and vegetation growth, although some snow (especially in depressions) remained throughout.

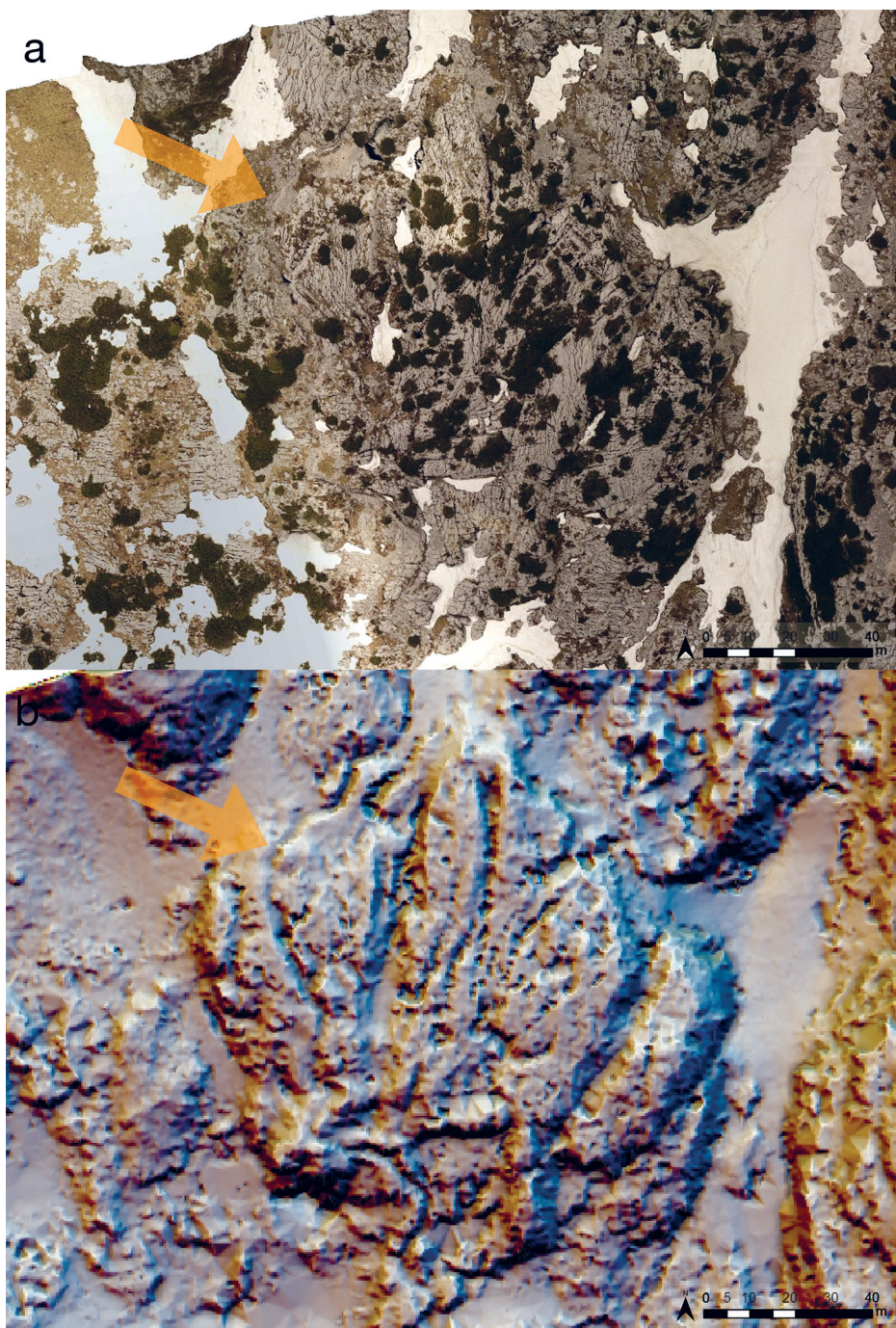
The creation of a Digital Terrain Model (DTM) from the ALS data proved to be a huge challenge. The study area was scanned with a 15 points per square metre resolution, however, after the filtering, average ground point density is below 2 points per square metre. Due to the snow patches and dense shrubs there are also continuous areas with no ALS data. The DTM thus suffers from low point density and interpolation artefacts. The difficult landscape played an active role in the survey, influencing the recording of features and quality of results (Figure 8.3).

However, the first impressions from the visualisations of the ALS data are of the sheer materiality of this landscape. The DTM provides a vivid view of this high alpine karst limestone landscape, with erosional features such as limestone pavements, perched funnel dolines, karst depressions, but also of landslides, cliffs, steep slopes, rockfalls and overhangs. This provides a new way of observing landscape, with no separation between features and environment or landscape, nor between ‘cultural’ and ‘natural’ features. Both are treated as the same – as one.

This makes it obvious that the landscape was not just a setting for human activity, nor was it an artefact resulting from human activity, but instead it was an active participant in past behaviour (Mlekuž 2013). It is crucial when we discuss this high alpine conflict landscape to understand that the physical landscape (the materiality) is an important actor in shaping the behaviours and identities of people.

Thus working with the visualisations of the ALS topographic data allowed us to extend our study beyond ‘significant’ isolated features (separate ‘sites’) of the landscape to the landscape as a whole. Fortifications, defensive structures, shell holes and other traces of conflict can be understood as an integral part of a landscape. Landscapes bear scars of conflicts, and vast stretches of this particular landscape were forever transformed.

This created significant challenges in the identification of traces. Sometimes it was almost impossible to distinguish between natural features (cracks, fissures, crevices, clefts, rock faces) and anthropogenic features, as the natural ones were often used and remodelled as trenches and other defensive features. This necessitated field survey and ground observation to understand more fully the character of these features.



8.3 Aerial photograph (a) and multiple hillshaded DTM of a trench incorporated in a fissure near Kraljišče (b). Note the patches of snow in depressions, dwarf pine (*Krummholz*) patches and the low quality of the DTM. © Institute for the Protection of Cultural Heritage of Slovenia, Centre for Preventive Archaeology (IPCHS CPA)

Results

The oldest layer of the conflict landscape which can be observed is associated with the fortification of the Koritnica gorge. Besides Kluže fortress on the western bank of the Koritnica River, we can observe several other features on the opposite bank, which today lie in dense woodland. These remains consist of former roads, probably the relicts of a seventeenth-century roadblock, as well as terraces just above the contemporary road, a stone rampart or the remains of a stone wall rising up the ridge, and a ditched elevated circular plateau with terraces to the northeast immediately above it. Of much interest are also three features formed by the parallel lines of ramparts and the remains of stone walls.

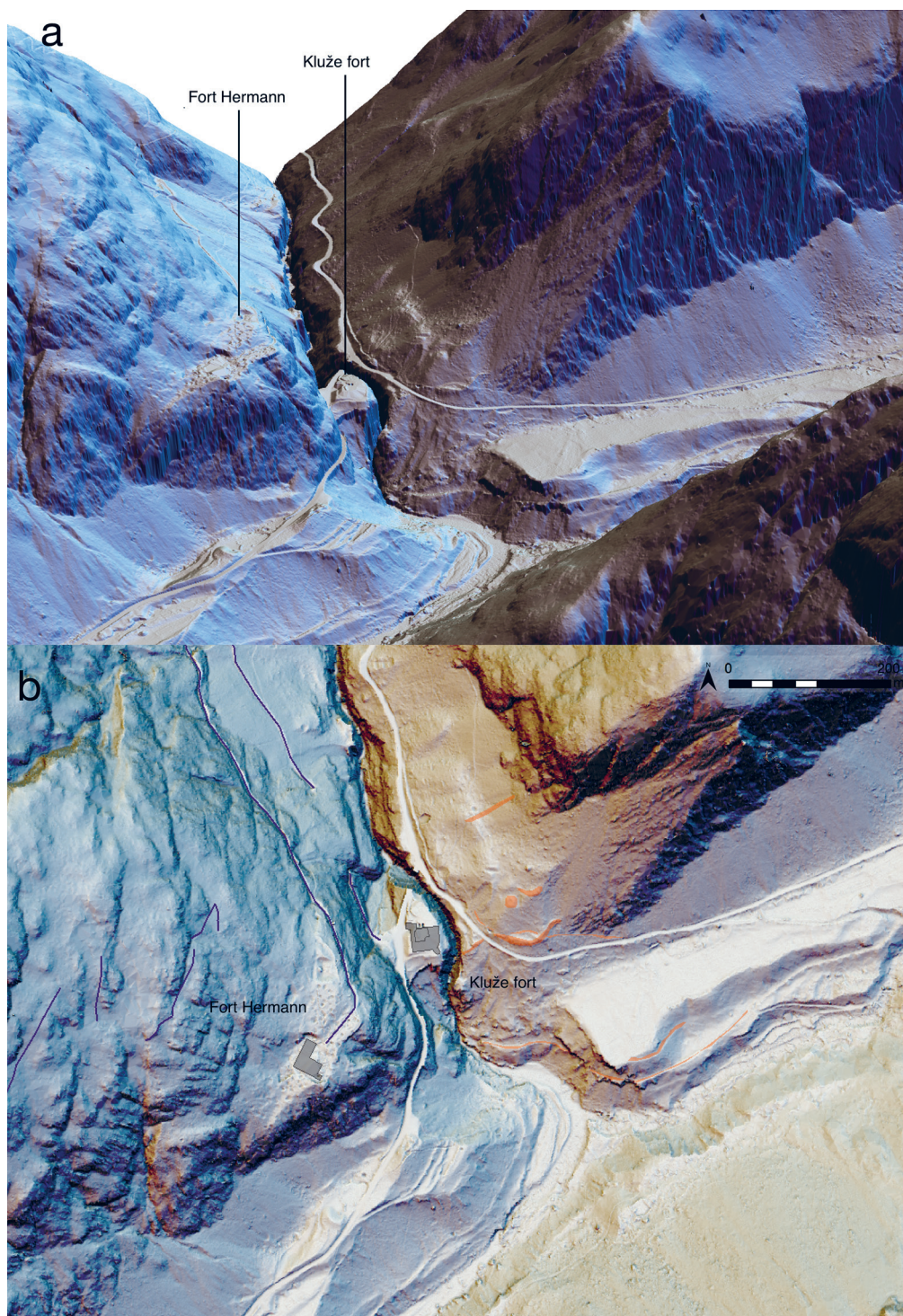
On the western bank of the Koritnica River there are numerous features. Moving from the valley we can trace the rock-cut road with a tunnel and caverns leading up the mountain. Around Fort Hermann, there are terraces that formerly held barracks, along with numerous craters – traces of the heavy shelling of the fort in 1915 (Figure 8.4). The ALS also provides a detailed and precise 3D map of the World War I Rombon battlefield, giving a synoptic view of this alpine conflict landscape. In this way not only were trenches and other defensive features mapped, but the whole battlefield, including communication routes and shell craters. The ALS thus significantly complements historical maps, and reveals relations between defensive features and complex topography, bringing a deeper understanding of the conflict (Figure 8.5).

Besides a straightforward identification and recording of features, conflict landscapes can be also approached from the standpoint of terrain analysis. This approach has its roots in military history, and tries to view the terrain in the same way that a military commander might. It aims to explore the landscape from the perspective of battlefield tactics.

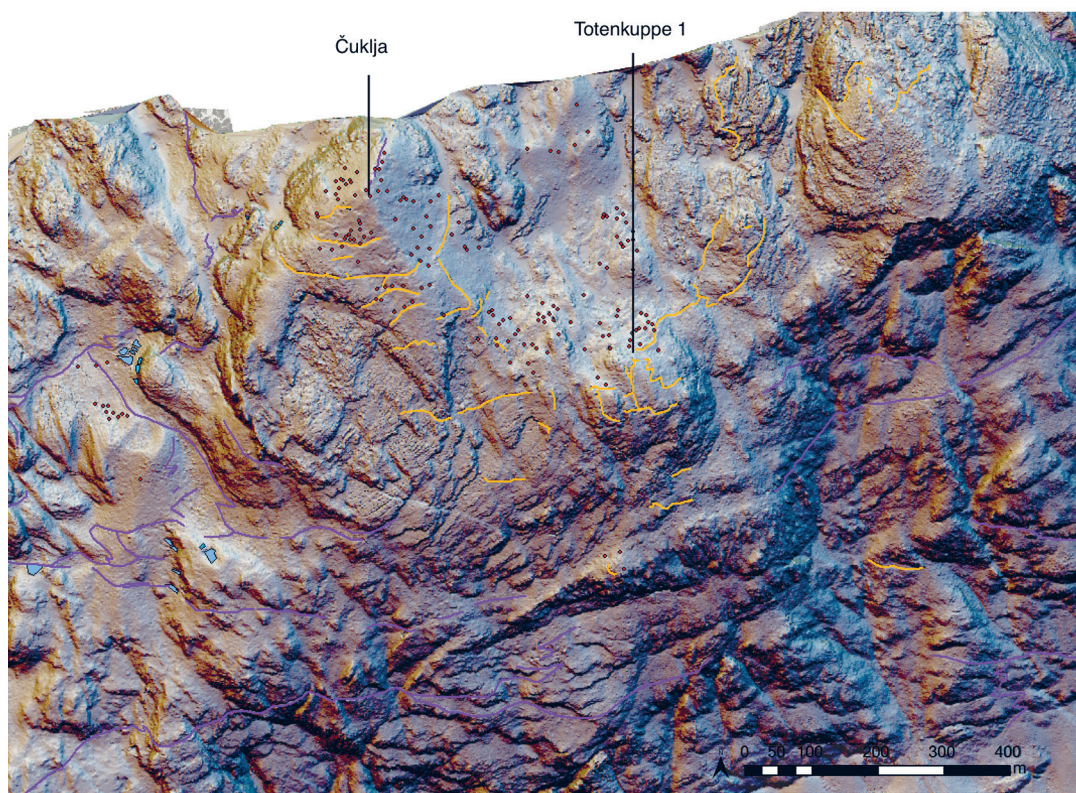
A common tool for this type of analysis is a set of principles known as KOCO A, an acronym for Key terrain, Observation, Cover and concealment, Obstacles, and avenues of Approach (McMasters 2009, Babits 2014). KOCO A analysis was developed to examine historic battlefields from a topographic strategic perspective.

‘Key terrain’ comprises locations, such as high ground, that would give an advantage over opponents. The acquisition of these ‘key terrain’ features is a main objective of the conflict. Historically, the Koritnica gorge along with the corridor along the Koritnica River were such features. However, with the introduction of artillery, Mount Rombon and other peaks which would allow observation and control over the landscape also became key strategic points. The battles for Mount Rombon were mainly fought on its southern slopes, and here two particular locations played the key roles.

The first location is Čuklja peak (1,767 metres), which was an important strategic point for Italian attacks towards Mount Rombon. From this location the Italians had a large field of view and control over the Austro-Hungarian



8.4 3D view of the Koritnica gorge from ALS data (a) and features identified (b). © Institute for the Protection of Cultural Heritage of Slovenia, Centre for Preventive Archaeology (IPCHS CPA)



8.5 Rombon battlefield with trenches (orange), pathways (purple), shell holes (red) and building platforms (blue).
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positions in the Bovec basin. The ALS data allows us to identify the system of fire and communication trenches that are partially buried by erosion on the steep slopes. The exception is a long and almost 3 metre deep communication trench which was in some parts carved in solid rock.

The other piece of key terrain was Mrtvaška glava (Totenkuppe 1). Here a network of trenches and fortified positions were built by Austro-Hungarian soldiers. Preserved on the summit are the remains of a group of stone and concrete-built trenches, as well as the remains of machine-gun posts (both in caverns and in the open).

The Soča Front, like the Western and Eastern Fronts, was characterised by trench warfare. Vast stretches of these features can still be traced today. In the Soča Valley, along the plains and adjacent high peaks, the topographical challenges required local adaptations to the trench system of warfare (Figure 8.6). The Austro-Hungarian military engineers in particular were adept at maximising the tactical and strategic advantages of topographical defence. According to military maps the Austro-Hungarian army had a great number of machine-guns and mortar positions on Mrtvaška glava, some of whose positions can be identified as rectangular entrenchments. Due to the steep slopes south of the Mrtvaška glava, the positions were not joined together; rather segmented fortified positions were more common, the majority of which can be identified on the DTM.

On the summit a group of stone and concrete reinforced trenches were built. A communication trench leads from Mrtvaška glava northeast to locations known as Kraljišče, where the Austro-Hungarian headquarters for the Mount Rombon battlefield were located. The shell crater density visible in the ALS data gives some insight to 'key terrain', as this section of the front was the focus of intensive shelling and fighting.

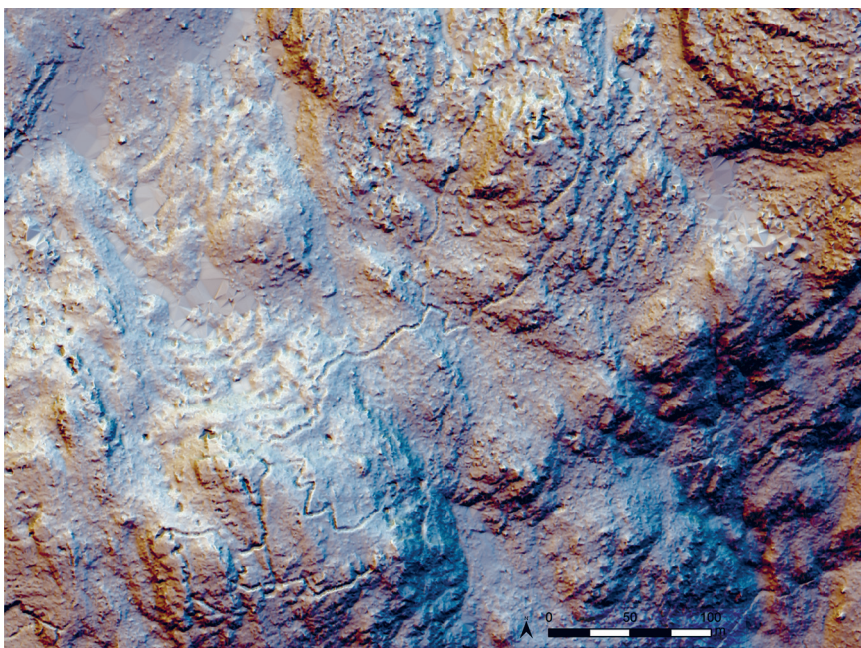
The ability to 'observe' enemy forces while being protected from them gives a clear advantage. In addition to being able to spot any attempts at attack, having a clear field of view allows for unobstructed fields of fire. The battles on the slopes of Mount Rombon were fought over control and command of the key observation points over the Koritnica gorge and Bovec basin.

Anticipating the conflict, the Austro-Hungarian Army started building an artillery observation post on Veliki vrh (1,306 metres) in the autumn of 1913, which was finished in October 1914 (Simić 2005: 188), becoming one of the observation points for the Bovec fortresses (Sperre Flitsch, [Figure 8.7](#)). During World War I the location was named Kote dreizehn dreizehn (Height 1313), a name which endures to the present (Simić 2005: 193). In wartime, the complex was also a part of the last Austro-Hungarian line of defence, to be used in case the Italians captured Mount Rombon. Several pathways, trenches and building platforms can be recognised, including the artillery observation post (*Beobachter*) and the range measurement post (*Distanzmesser*).

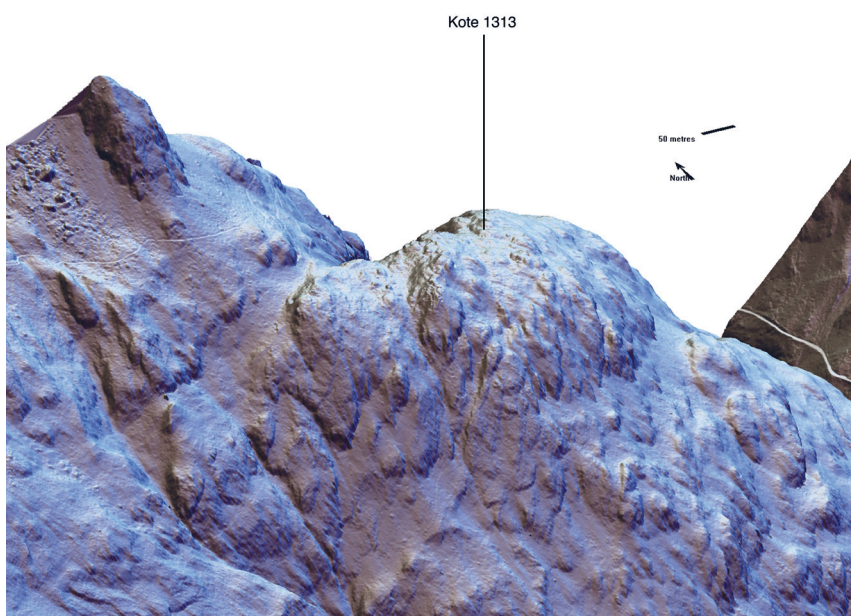
'Cover and concealment' are features of the landscape, natural or modified, that serve to protect from enemy fire. In mountain warfare exposed bedrock enhanced the killing power of grenade, artillery and mine attacks. Flying rock splinters made explosions far more lethal than in the lowlands. Additionally, geomorphological features offered many opportunities for using and extending deep caverns which afforded protection from artillery fire. The size and complexity of such features depended on their purpose and the availability of suitable bedrock outcrops. An important element of mountain warfare was the cavern, carved out of the mountain rock, serving as a place of relative protection – as with the familiar dugout of the Western Front – and which was crucial for soldiers' survival. These features are very difficult to interpret only by remote sensing images, as only their entrances can be identified. Caverns were usually located behind small ridges. Some of them were to accommodate soldiers, others were used to store ammunition, still more were used as machine-gun posts, searchlight or artillery emplacements.

In a hostile landscape, only some degree of protection is offered by the caverns hewn into the rock. Elsewhere we can see the desperate struggle to seek cover, as every natural feature that offered some protection was used for this purpose (including cliffs, overhangs and depressions).

Caverns and buildings are not so common on the southern slope of Čuklja, due to the site's exposure to enemy fire. A large number of caverns and building platforms are, however, located under the cliffs on the western Čuklja slope. There was also an Italian hospital and a medical station with small cemeteries located in the vicinity. Building platforms are also visible as well as shell craters in some areas.



8.6 Trenches on Totenkuppe 1 integrated in the topography. © Institute for the Protection of Cultural Heritage of Slovenia, Centre for Preventive Archaeology (IPCHS CPA)



8.7 3D view of Kote 1313 from ALS data. © Institute for the Protection of Cultural Heritage of Slovenia, Centre for Preventive Archaeology (IPCHS CPA)

'Obstacles' are features that may prevent or delay the movements of a military force. Here the whole landscape is a huge obstacle, with rugged topography and steep slopes. This hostile and inaccessible landscape was further enhanced by man-made obstacles, constructed from mass produced material, such as barbed wire, and other obstacles that had to be brought up from the valley.

'Avenues of approach' are features that allow mobility and supply. As there were no previous communication paths in this landscape these had to be built anew. This is a key function as the *Materialschlacht* (or war of attrition / war of material culture, see Saunders 2000: 44 and Saunders 2011: 39) relied on the constant supply of stuff and bodies. Thus mule-ways or *mulatiere* are still one of the most visible features in this landscape. They were built for mules and people, and they are still used as hiking trails or downhill cycling trails.

However, this short exercise in military analysis is a view from a distance, a view that emphasises a functional understanding of conflict, and only adds material details to the military history of the conflict. It fails to understand the complexities of conflict landscapes and the intensity of industrialised warfare.

Field Survey

Things that are difficult to see from a distance may be inspected from the ground. The close perspectives offered through field surveying brings additional insights to the vast quantity of remains, their preservation and post-abandonment processes, and the attrition of remains in the harsh environmental conditions and from scavenging and relic hunting. In many cases the interpretation of features cannot be made from the remotely-sensed data and requires ground-truthing. Therefore a field survey was carried out using GPS to map the remains on the Mount Rombon battlefield with additional documentation using a digital camera. This showed many remnants of the war, from deep trenches, caverns, barracks platforms, machine-gun positions to the material culture of war and soldiers' everyday life.

The majority of features encountered on the ground are fire and communication trenches dug into the ground or cut into solid rock. Trenches often followed the forms of rocky terrain in the similar way as roads and pathways were built behind overhangs and ridges to conceal them from the enemy. The solid limestone bedrock is close to the surface in these areas, making the digging of trenches difficult and time-consuming. Consequently, trenches and fortified positions here were often built from dry stone walls or as shallow trenches. Some trenches have a stone parapet added at the ground level as stones were the main building material. The use of concrete is rare, but in some places stone and concrete constructions are known. In a few of the Italian trenches on the Čuklja slopes, original wooden posts and wire mesh from trench construction were found, some of them *in situ*. Due to erosion the majority of the trenches on Čuklja are infilled and can sometimes be traced

only as lines of stones on grassy slopes. The caverns, that are almost impossible to discern from the ALS data, are easily recognised on the ground. They differ in shape and size. Some have more than one entrance with special rooms for accommodation; others are small and were used as ammunition stores. Some contained machine-gun or observation posts or artillery emplacements. The caverns and barrack platforms were usually built behind overhangs or ridges that protected them from direct enemy fire (Figure 8.8). During fieldwork some machine-gun and mortar positions were also recognised and correlated with positions marked on military maps.

As we could observe in the field, the majority of structures were built using the surrounding terrain to its advantage and especially for the purpose of concealment.

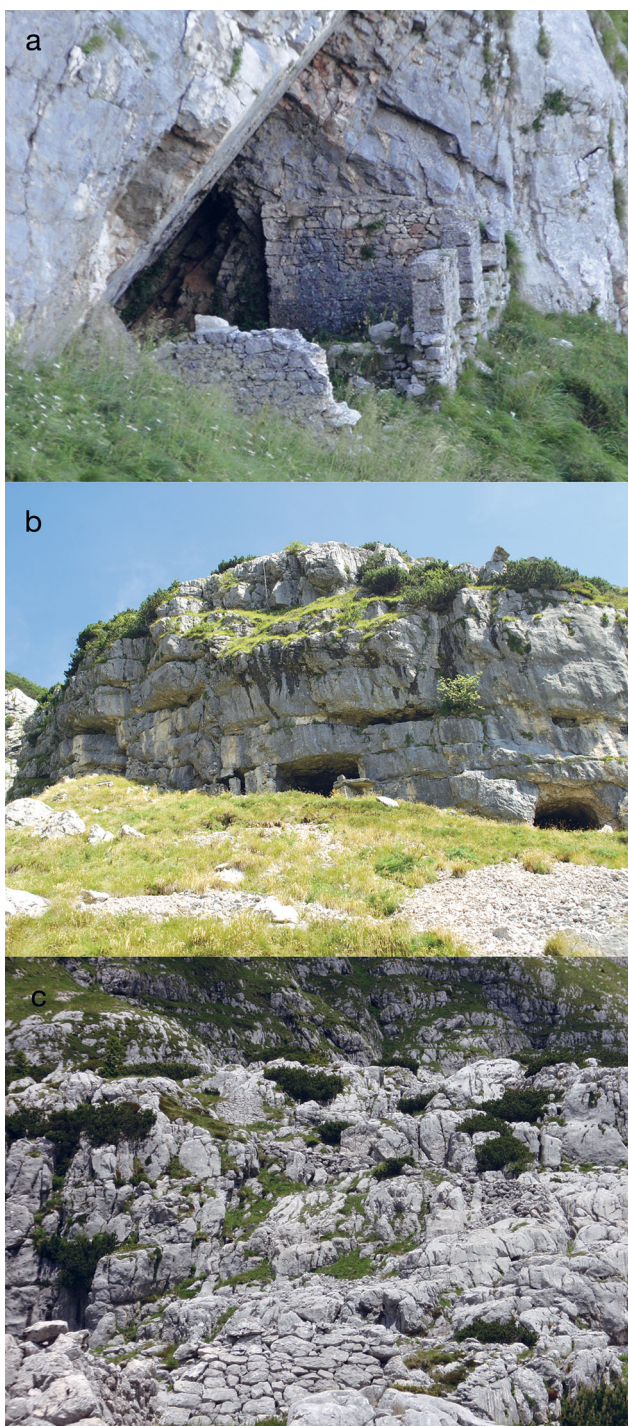
The close perspective offered by field survey, provides insight into post-abandonment deposition processes, the attrition of remains due to the harsh environmental conditions and to relict and souvenir hunting. But it also shows the skills of converting 'natural' features into shelters, demonstrating how fissures were transformed into trenches by building low stone walls, or how structures were skilfully incorporated into cliffs and overhangs. The physical landscape and defensive features are interwoven, creating places fully incorporated into the surrounding area, their form, dimension, context and structure the result of complex and lasting interactions with a changing landscape.

On the other hand, survey allows us to experience the landscape from an embodied perspective (Tilley 1994). The difficulties of conducting survey in a high alpine landscape, such as lack of water, physical exhaustion due to the difficult terrain, and exposure to the elements, can provide a rich bodily experience of being there, an experience that remote sensing can never offer.

Field survey also gives insight into daily life during the conflict in the form of graffiti and memorial inscriptions that can be found in several locations, creating a memorial landscape in this high mountain environment. Conflict landscapes reveal and embody more than simply the remains of militarisation and/or conflict; they simultaneously contain and constitute a variety of associated commemorative and monumentalised places and features created during and in the aftermath of the conflict. Monumentalisation of the Čuklja peak continued after the conflict with the erection of a monument to Italian soldiers, and was influenced by the rise of Fascism and the mythologising of the 'Great War' and the Italian victory (Saunders et al. 2013).

Discussion

Conflict landscapes were not just boards where war games were played and not just arenas for social actions. Instead they were perceived as, and embodied, sets of relationships between places, a structure of human feeling, emotion, dwelling, movement and practical activity.



8.8 Building sheltered by a cliff (a), caverns hewn into the rock (b) and trench parapets constructed as dry stone walls (c). © Uroš Košir

In his study of the World War I Western Front Wilson (2011) examines how soldiers in the trenches would have experienced their surroundings and how they came to understand those hostile landscapes. According to Wilson, one significant way that soldiers came to understand themselves and their environment was through witnessing moments of death, violence and suffering.

In the landscape of the Soča Front there is an additional component, the environment itself. Mountains, at any time of year, are dangerous – lightning, high wind, rock fall, extreme cold, avalanches. But in war, these dangers are multiplied. The whole landscape is hostile. Movement, medical evacuation and resupply involves enormous efforts. Any built-up stone wall can become a fatal trap. The number of casualties from bullets, grenades and artillery shells is increased with ricochet and splintered rock.

Furthermore there is thirst, water is locked up most of the year in winter ice or lost in limestone. Winter brought an abundance of snow, and many barracks collapsed under the weight. Avalanches also presented a threat, killing many soldiers. Extreme cold made frostbite a common condition. Photographs and reports from both the Italian and the Austro-Hungarian sides show how the soldiers suffered identical harsh conditions in trenches and suffered atrocious deaths in hand-to-hand combat over a few metres of barbed wire and rocky terrain.

Soldiers' perceptions of the conflict landscape were constrained by the military hierarchy and the development of the conflict. This is the subject of military terrain analysis. But even so, individual soldiers were not just pawns, or *Kannonenfuter*, but agents, who were struggling to preserve their integrity and identity, and fighting to survive. They would conform to the orders passed down from commanding officers, but there would also be resistance of all forms.

Traditional studies see the battlefield landscape as a setting or arena of conflict, as an 'artefact' of the military occupation. However, conflict landscapes can also be understood as agents, active nonhuman and 'more-than-human' entities that force us to reconsider the disruptive capacities of the material world. How is the social embedded within the materiality of the world? How can bodies be pushed in extreme conditions and life take shape and gain expression in shared experiences, everyday routines, practical skills, affective intensities, enduring urges, unexceptional interactions and sensuous dispositions within the context of war, hostile landscape, suffering and dying (Macpherson 2010, Yusoff 2007, Thrift 2007). Bodies in this landscape were pushed to the limit, and profoundly changed – even if their physical integrity was preserved. Soldiers were isolated from the rest of society, set in a hostile landscape of death and suffering, industrialised killing and destruction. In order to survive they had to rely on new material practices of survival and ultimately created a new society, isolated from normal experiences, and bonded by prolonged camaraderie and based on new senses of collective identity, based on common suffering and self-sacrifice (Payne 1996: 75). These experiences sedimented in their bodies.

When they finally returned to civilian life, they had to cope with a changed world, during periods of great political and social economic upheaval. The rise of Fascism after World War I drew on an idealisation of a sense of protection, shared suffering and comradeship in the trenches. The experience of the Mount Rombon landscape had a profound effect on the later Italian dictator Benito Mussolini who was stationed in positions in front of Čuklja between 17 February and 2 March 1916. He described his experiences in his war diary *Il mio diario di guerra 1915–1917* (Klavora 2000: 165–9). The landscape sedimented in soldiers' bodies distributed itself and acted through their bodies, shaping lives and history for many years after the conflict.

Conclusion

Conflict archaeology benefits from drawing on complementary theoretical perspectives and methodologies. Thus, the role of remote sensing and field survey is not simply the straightforward recording of battleground features, but it should bring new understanding of conflict landscapes and reveal different aspects of them. Remote sensing, with the detached and non-selective distant view, allows us to understand the landscape as a whole, a cumulative result of forces very much greater than a single human life. Field surveys provide human perspectives of conflict landscapes, as they reveal evidence of material practices of individuals thrown into conflict, trying to preserve their integrity and identity against violent forces much larger than a single human life.

In the context of the Soča Front, the ALS survey provided the first synoptic view of the conflict landscape, extending understanding beyond isolated features to the landscape as a whole. In this way trenches, artillery positions, mule-ways, building platforms, shell holes and other traces of conflict can be understood as an integral part of a multi-layered landscape – a landscape that was itself an important agent in the development of conflicts. This perspective informs field survey as well. Field survey was not used only as a tool for recording and identifying features, but as an approach that provided additional insights and a complementary understanding of the conflict landscape. Both integrated approaches resulted in a richer understanding and 'thicker' description of the high alpine landscape of death and suffering.

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References

- Babits, L.E. (2014) Appendix. METT-T, KOCOAA, and the Principles of War: A Template Guiding a Better Understanding of Battlefield Behavior and Detritus. In C.R. Geier, D.D. Scott and L.E. Babits (eds) *From the Honored Dead: Historical Archaeology of the American Civil War*, pp. 263–70. Gainesville, FL: University Press of Florida.
- Carman, J. (2013) *Archaeologies of Conflict*. New York: Bloomsberg.
- Galić, L. (2007) Vojne operacije na območju odseka IV (Krn – Predel). In L. Galić and D. Pirih (eds) *Od Krna do Rombona: 1915–1917*. Tolmin: Tolminski muzej.
- Klavora, V. (2000) *Plavi križ: soška fronta: Bovec 1915–1917*. Celovec, Ljubljana, Dunaj: Mohorjeva družba.
- Klavora, F. (2007) *Bonaparte ob Soči 1797*. Bovec: self-published.
- Košir, U. (2012) Potencial arheologije prve svetovne vojne na območju soške fronte / The Potential of First World War Archaeology on the Soča Front. *Arheo* 29: 53–64.
- Macpherson, H. (2010) Non-Representational Approaches to Body-landscape. *Geography Compass* 4(1): 1–13.
- McMasters, K. (2009) *KOCOAA (Military Terrain Analysis) – Cheat Sheet*. Washington, DC: National Park Service.
- Mlekuž, D. (2013) Messy Landscapes: Lidar and Practices of Landscaping. In R. Opitz and D.C. Cowley (eds) *Interpreting Archaeological Topography: Airborne Laser Scanning, 3D Data and Ground Observation*, pp. 88–99. Oxford: Oxbow Books.
- Opitz, R. (2013) An Overview of Airborne and Terrestrial Laser Scanning in Archaeology. In R. Opitz and D.C. Cowley (eds), *Interpreting Archaeological Topography: Airborne Laser Scanning, 3D Data and Ground Observation*, pp. 13–31. Oxford: Oxbow Books.
- Payne, S.G. (1996) *A History of Fascism 1914–1945*. Madison, WI: University of Wisconsin Press.
- Saunders, N.J. (2000) Bodies of Metal, Shells of Memory: ‘Trench Art’, and the Great War Re-cycled. *Journal of Material Culture* 5(1): 43–67.
- (2011) First World War Archaeology: Between Theory and Practise. In F. Nicolis, G. Ciurletti and A. De Guio (eds) *Archeologia della Grande Guerra: atti del convegno internazionale: 23/24.06.2006 / Archaeology of the Great War: Proceedings of the International Conference*, pp. 37–46. Trento: Provincia autonoma di Trento.
- Saunders, N.J., N. Faulkner, U. Košir, M. Črešnar and S. Thomas (2013) Conflict Landscapes of the Soča/Isonzo Front, 1915–2013: Archaeological-Anthropological Evaluation of the Soča Valley, Slovenia. *Arheo* 30: 47–66.
- Simić, M. (1998) *Po sledih soške fronte*. Ljubljana: Mladinska knjiga.
- (2005) *Utrdbi pod Rombonom: predstraža soške fronte: razplet svetovnega spopada med utrdami in topovi na Bovškem*. Ljubljana: Rombon.
- Thrift, N. (2007) *Non-representational Theory: Space, Politics, Affect*. London and New York: Routledge.
- Tilley, C. (1994) *A Phenomenology of Landscape, Places, Paths and Monuments*. Oxford: Berg.

- Wilson, R. (2011) Archaeology and the Battlefields: An Ethnography of the Western Front. *Assemblage* 11: 1–14.
- Yusoff, K. (2007) Antarctic Exposure: Archives of the Feeling Body. *Cultural Geographies* 14(2): 211–33.



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The 'Gas-scape' on the Eastern Front, Poland (1914–2014): Exploring the Material and Digital Landscapes and Remembering Those 'Twice-Killed'

Anna Zalewska

Abstract

This chapter examines the relationships between events that took place near the Rawka and Bzura Rivers (Mazovia, Central Poland) during World War I, and the persistence of material remains in the landscape and the memories of them. Field-walking and Airborne Laser Scanning (ALS) data demonstrate the extent of the former battlefield to archaeologists, and also to long-term residents. However, while the collective local memory extends to gas attacks that took place a hundred years earlier in the area, to date this is not strong enough to generate respect for the landscape and to stop anthropogenic, post-depositional and destructive processes. It is assumed here that the phenomenon of 'Gas-scape' can adequately communicate all consequences (both mental and material) of the processes that were initiated by the massive use of chemical weaponry on 31 January 1915, and which are still continuing. This unique landscape is presented here as a socially causative force, one that continues to act even today. The 'Gas-scape' goes far beyond the mere theatre of war, the stage on which 'killing culture' was born. It is also the scene of on-going, post-depositional and hopefully pro-social (cognitive, artistic, pop-cultural but also non-human and so on) processes. It is tilted towards the future, as a warning, but also an inducement to think, with the support of archaeology, of reconciliation. It can also be seen as a touchstone of the actual potential of ALS when it is applied to the cognitive process as well as other pro-depositional processes – providing support to protect the *in situ* existence of that complex, causative and meaningfully palimpsestic landscape scarred by World War I.

Keywords: World War I, Eastern Front, 'Gas-scape', depositional processes, ALS visualisations, conflict archaeology, archaeology of reconciliation.

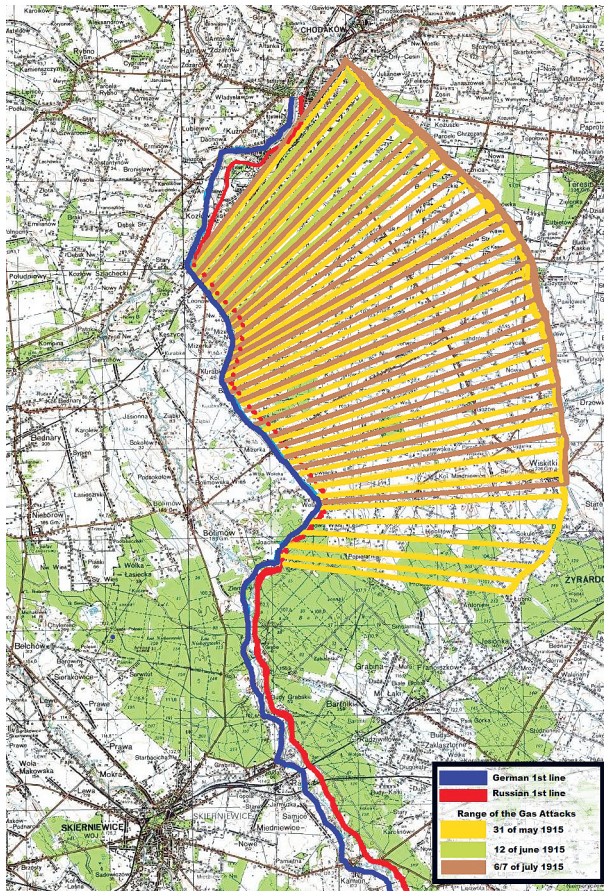
Setting the Scene

Positional warfare should in fact be described in terms of history of the landscape into which the armies march and which they leave behind when moving to the next field of battle. What remains is the very landscape, and the dead, whom mother Earth takes back to her bosom. (Wennrich 1935: 78)

The Battle of Rawka and Bzura (Central Poland) fought from December 1914 to July 1915 was among the bloodiest engagements of World War I on the Eastern Front, during which an estimated 100,000 soldiers died (Figure 9.1). While Allied forces on the Western Front were gradually giving ground, in the east the German Army was being attacked by the Russians. Russian involvement in the war stemmed as much from Tsar Nicholas II's commitment to his allies as from his ambitions for territorial expansion. Urged by France to strike as soon as possible, on 16 August 1914, the Tsar's army attacked East Prussia, creating an Eastern Front that forced German commanders to divide their forces. The war at the Eastern Fronts may be characterised as a war of annihilation, and one with racial overtones which saw an estimated 500,000 Jews and 743,000 Poles expelled from their homes by Russia (Kramer 2007) and the transformation of a rural landscape into a terrible war zone. In the territory of present-day Poland material and cultural losses were similar to the worst affected areas near the frontline in Belgium and northern France. In addition, more than 400,000 Poles were killed and 800,000 were injured fighting for three empires (Górny 2014: 49). Nevertheless, it is still not obvious to many Poles if World War I should be regarded as 'ours' (Borodziej and Górny 2014).

The Battle of Gumbinnen on 20 August 1914 saw the Russian 1st Army under General Paul von Rennenkampf force the withdrawal of German forces in East Prussia. However, the victory at Tannenberg (17 August – 2 September 1914) gave the Germans a viable chance of taking Warsaw. Already by mid October 1914 they had advanced to the Błonie-Pruszków-Piaseczno line (just a few kilometres from Warsaw), but were later pushed back as far as Włocławek. As they retreated bridges, railway tracks and stations were destroyed, which greatly hindered the Russian capacity for resupply and ultimately stalled the counterattack. In November the German Army, reinforced with troops from the French and Belgian front, began its advance towards Łódź. What followed was a bloody, offensive campaign which has been described as 'the largest manoeuvre battle' on the Eastern Front (Daszyńska 2011). The Łódź offensive ended in German defeat, as the Russians forced them into a trap and almost completely surrounded the massive German force in the area between Łódź, Koluszki and Brzeziny. However, because of General Rennenkampf's indecisiveness and lack of military expertise, the German troops escaped, and Rennenkampf and General Scheidemann, commander of the 2nd Army, were subsequently both dismissed (Zalewska et al. 2014: 3–5).

Bloodied, the Russians decided in late November 1914 to shorten the frontline, seeing the dynamic mobile conflict of the Łódź operation gradually evolved into static positional warfare in the area of the Rawka and Bzura Rivers.



9.1 Map of the Eastern European 'Gas-scape'. The red line represents the Russian, the blue, the German frontlines, while the tri-colour stripes represent gas attacks. Source private collection of A. Zalewska and J. Czarnecki

Here the Russian Army set up defences with the goal of stopping the German offensive moving towards Warsaw, taking advantage of the lie of the land by building a formidable line of trenches and fortifications on the eastern bank of the Rawka, recollected by a former German soldier:

That was where the positions were, where Polish Death roamed day and night, always ready to crush any form of life. As men dug themselves into protective soil, he had to settle for killing trees. Throughout the battle front, all that reached towards the sky were broken, shell-torn stumps, naked stubs – which, in the dead of night, industrious riflemen would wrap in wire turning them into yet another line of defences. In the forests of the Rawka one went to sleep to the sound of exploding grenades and woke up to infantry rifles and machine gun fire. (Wennrich 1935: 78)

In the first phase of the battle the most intensive fighting, the so-called Battle of Humin, occurred between 31 January and 2 February 1915. At least 90 heavy and light artillery batteries were used to break the resistance of the Russian Army entrenched behind the banks of the Rawka, as well as to divert attention from a planned attack on East Prussia. On the 10 kilometres long frontline the Russian Army lost 40,000 soldiers in just three days.



9.2 ALS data visualisation of the area (indicated by a dotted line) which deserves the greatest attention and both cognitive and social care, and which, after the first season of research was recommended by archaeologists in December 2014 as the potential area of a 'Monument of History' (oryg. 'Pomnik Historii' – one of the highest forms of protection in Poland). Source raw data from GUGiK resources – licence No. DIO.DDZ.7211.15877.2014_PL_N; A. Zalewska: concept and G. Kiarszys: visualisation. © Project APP

One of the reasons for this great loss of life was that soldiers were deployed in accordance with directives still rooted in nineteenth-century strategy, which stipulated one person per metre of the frontline. The other reasons were the character of the landscape which saw soldiers getting stuck in the slush, and the belief of at least some soldiers that their sacrifice was needed for the greater good:

The Russian Army facing us across the Rawka and defending the Warsaw fortress needed to be prevented from sending troops to the north and south. ... This was why we had to offer them our bodies, unreservedly, as shooting targets; but it was also why we, fighting on the Rawka, could claim, in our blood-splattered war journals, some of the credit for the successes in Mazuria and the Carpathians. (Duncker and Eisermann 1927: 45)

After the harsh winter battles there was a period of relative stabilisation on the frontline. This situation continued until July 1915, when the Russian forces quietly withdrew.

The material traces of the fighting are clearly visible on visualisations of Airborne Laser Scanning data (ALS), especially in parts of the so-called no man's land (Figure 9.2), which have been protected from subsequent attrition by the growth of the Bolimów forest.

Depositional Processes on the Eastern Front 'Gas-scape'

The war in this region saw at least four times the deployment of chemical weaponry by the Germans as they found themselves unable to breach Russian defences in any other way (Kaliński 2010). The first deployment, on 31 January 1915, was also driven by wider strategic considerations as preparations for the winter campaign in Mazuria were well under way. Attacks on the Polish bend of the Vistula had been reduced to a few skirmishes:

To keep Russians on their toes and convinced that the attack was continuously ongoing, the 9th Army was ordered in late January to attack with full force in the area of Bolimów. With that in mind, the High Command issued 18,000 shells for our use, gas ammunition to be precise. It is important to understand, in the context of those times, that such a vast amount of ammunition was something quite extraordinary. (Duncker and Eisermann 1927: 42)

The artillery shells were filled with the so called 'T-Stoff' (xylyl-bromide) agent and Ni-shrapnel containing an irritant ('sneezing powder'). The attack was regarded as unsuccessful, with failure blamed on the low temperature (-3 degrees Celsius) which curbed the destructive power of the 'T missiles' (Hoffman [1923] 2013: 52). However, as General Ludendorff recalled in his war memoirs, the main objective of keeping the Russians too preoccupied to take an interest in the German attack in East Prussia was accomplished:

We took several thousand soldiers captive; beyond that, the tactical success was limited. However, the impression that the attack had on the Russians was great. ... We had achieved what was expected in the area of strategy. (Ludendorff [1921] 2014: 107–8)

The Germans' next attempt to use gas took place four months later, shortly after the first large-scale military use of poisonous gases near Ypres in Belgium on 22 April 1915. On 31 May 1915 chlorine was deployed in the area between Majdan and Zakrzew, where the Germans placed 1,200 steel canisters along the frontline and released 240 tonnes of heavier-than-air chlorine. This was done by a special gas unit, Pionier-Regiment Nr. 36 led by Colonel Goslich, which, like Pionier-Regiment Nr. 35 led by Colonel Peterson, consisted of scientists, chemists and chemical industry workers. This new form of attack took the Russians by surprise, and at least the 53rd, 54th, 55th, 56th Siberian Regiments (14th Siberian Division) and as well the 217th and 218th Infantry Regiments (55th Infantry Division) lost 1,183 soldiers on the battlefield and up to 10,000 were poisoned, a significant number of whom died later in hospital (Umiastowski 1933). However, the German troops (who lost approximately 500 dead and wounded) failed to make any significant headway and breach the enemy lines as the effectiveness of the gas was compromised by the wind carrying the gas over the Russian frontlines and having its greatest impact on the soldiers of the second line and those in support areas.

According to А. Николаевич Де-Лазари:

April and May saw the first significant cases of mass deployment of toxic chemical agents specifically on 22 April in Ypres on the Western Front and 31 May near Wola Szydłowiecka near Bolimów on the Eastern Front. Both these attacks demonstrated to all WWI combatants the real power of the new chemical weaponry. ... After those two attacks, both sides of the conflict were faced with the problem of effective countermeasures – a challenge complicated by their lack of experience in these matters as well as the variety of available toxic chemical agents that either side would eventually use in the course of the war. Those two attacks started a very particular war of gas versus 'anti-gas'. (Де-Лазари 1935: 17)

On 12 June 1915 a smaller amount (approximately 30 per cent of the former attack) of chlorine was deployed in the area between the villages of Sucha and Zakrzew. This time Russian troops (218th Infantry Regiment and the 23rd, 54th, 56th Siberian Regiments) lost 1,200 soldiers on the battlefield and 3,100 soldiers were counted as poisoned, of whom many later died (according to the testimony of Polish doctor Mortrym Żakowicz, after Umiastowski 1933). The German Army also suffered the effects of their own attack and in the Sucha River area approximately 350 soldiers were inadvertently poisoned. The attack was seen as very successful, allowing the Germans to penetrate 3 kilometres into Russian positions.

The last gas attack in the region took place during the night of 6/7 July 1915. This time chlorine was released from 9,000 cylinders on the broad section of the frontline between the villages of Wola Szydłowiecka and Zakrzew. Russian troops (218th and 220th Regiment, 21st and 22nd Siberian Regiment) were seriously affected, with about 5,000 soldiers dying in the trenches and many poisoned. However, a sudden change in wind direction pushed the gas back towards German positions, poisoning 1,450 soldiers and killing 139. Ten days after the July attack, the Russian Army withdrew from the Rawka with the Germans following in hot pursuit. The Germans commemorated their losses with a Pionier-Regiment Nr. 36 monument, next to the Church of St Anna in Bolimów (Figure 9.3).

The Russian Army withdrew beyond the Vistula, destroying crops and anything else that might be of use to the enemy as it went. The German Army followed and ruined villages and destroyed fields, and forests were left as silent witnesses of the events of 1915 (Figure 9.4). Afterwards life slowly returned to normal, as almost immediately some residents returned to their villages. Their descendants can still tell stories of their grandparents who clearly recalled the devastation caused by chemical weapons and artillery.

Post-depositional Processes: Disappearance and Oblivion

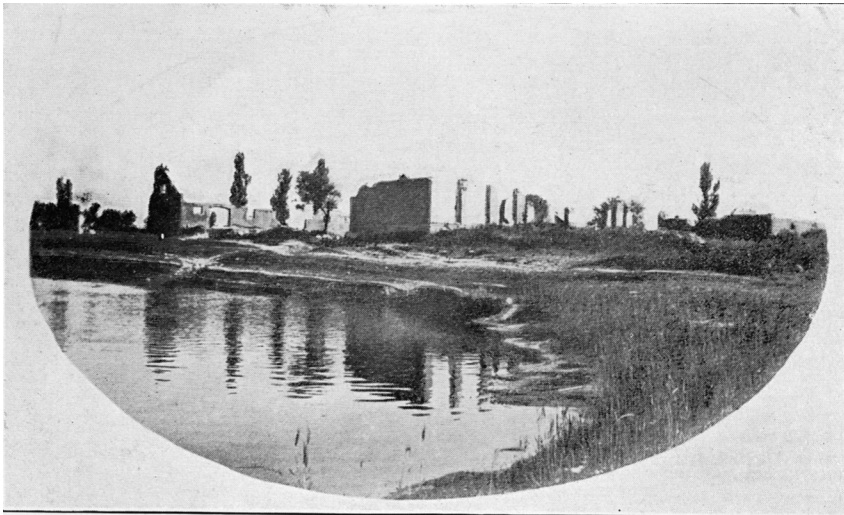
The landscape affected by gas was also marked by a number of other lethal and disruptive activities described in primary sources:

On average, during these long weeks, our regiment would fire 60,000 rounds a day, and the number was by far the lowest in the division. The soldiers had grown so accustomed to the continuous cannonade that once it ceased, they immediately grew restless ... There was one thing that the Russians did accomplish: the tall forest between the positions had been all but obliterated. The trees had been shot through so many times that they collapsed to the ground and lay there, in front of the lines, in heaped disorder. Those growing to the sides and behind our positions fared no better, every once in a while a tree would fall back there with a thunderous thump. (Rohkohl 1923: 66) (Figure 9.5)

The surface topography produced by the military actions began to transform soon after July 1915. Degradation, infilling and blurring due to natural post-depositional processes were accompanied by anthropogenic post-depositional processes. A hundred years later they have become the subject for archaeological studies. Hitherto, the archaeological examination of those specific, palimpsestic remains proved the legitimacy of using transdisciplinary approaches, such as 'modern conflict archaeology' (Saunders 2011).



9.3 The unique evidence of the presence of a 'Gas Regiment' in Rawka: the monument dedicated to the Pioneer-Regiment Nr. 36, which used to be situated next to the Church of St Anna in Bolimów. Photography from the resources of the Archive of the Polish Army Museum, reproduced courtesy of its Principal, Z. Wawer



Reste des zerstörten Regts.-Stabsquartiers in Wis.-Bolimowska

9.4 A war landscape of ruined villages and destroyed fields and forests were left as silent witnesses of the events of 1915, pictured here close to Bolimowska Wieś. Source private collection of A. Zalewska and J. Czarnecki



Zerstörter Wald

9.5 The trees had been shot through so many times that they collapsed to the ground and lay there. Photograph of ruined forest close to Rawka River. Source private collection of A. Zalewska and J. Czarnecki

Theoretical Background: Pro-social Archaeological Activities as a Part of the Archaeological Cognitive Process

Such a specific object of study requires certain redefinitions and reflection at the meta-level. In general, so far three primary processes have been identified in the archaeological cognitive process (Urbańczyk 1981, Schiffer 1987).

1. pre-depositional process: defined as the 'original', 'socio-cultural', 'historic' processes, which many archaeologists treat as 'key' or 'proper' areas of interest;
2. depositional processes: which involve the extraction of the material correlates of culture from their socio-cultural context; and
3. post-depositional processes: described as source-producing processes (derivative to the original process, closely related to the same, and dependent on the specifics of depositional processes).

The characterisation of these processes encompasses the changes undergone by the material correlates of the existence of human groups, the depositional processes and stratigraphic systems. Their character (and sometimes significance) is revealed in the process of 'discovering the past', which is the manifestation of various cognitive acts (shaped, for example, by *a priori* judgements, interpretative paradigms and contexts), as they are perceived and understood by contemporaries.

While in general I accept the validity of the above proposition, I believe it should be stressed that archaeological study must also consider aspects beyond the three processes sketched above. This is because of the specificity and agency of landscapes and objects and the currently observed, far-reaching changes, which include considerable (and crucial from my point of view) 'anthropologisation' and socialisation of archaeological knowledge. Since cognitive activity creates socio-cultural contexts and is in turn itself shaped by those contexts, it should be able to relate to all aspects of the same and see all of them as significant parts of one process. Therefore, there is a need to treat them as integral and consistent with the cognitive framework of archaeology, as such causes, manifestations and consequences of the changeable roles and functions associated with material links to the past as well as the nature and agency of material remains. These include landscapes, including those touched by wars. Their recognition, re-presentation and preservation as *in situ* information can constitute the very substance of archaeology of the future. To the three processes outlined above I recommend adding (as an essential element of reflection) also a fourth: pro-social processes, which include among other elements the processes of socialising material remains initiated by archaeologists and the processes of empowerment of material remains. Particularly in terms of the archaeology of the contemporary past, it is necessary to reflect on the complexity of agency of and around the subject matter.

On the one hand, as archaeologists we deal with the causative forces of landscapes and places marked by recent history, as well as with things which have the potential to force reflections on the long- and short-term consequences of twentieth-century wars and so on. If we are able to recognise and protect their potential and further alert others to this, then we can help them to initiate, to be causative also in the future. This can assist in maintaining the integrity of the objects and processes rooted in the recent past (also those wrapped in memories of war) and in the maintenance of palimpsestic landscapes and sensitive places evidencing the outcomes of conflicts *in situ*. On the other hand, there are instances of individual and collective human activities in the present that significantly impact on the condition (substantial/material) of past remains, and which are caused by the popularisation of knowledge about the past to serve a purpose in the present. Such a purpose may be negative or positive. The former results in taking action detrimental to the historic environment and social relations with the past by hampering their transition to the future. The latter activates constructive (although not always easy) relationships with the past. A better understanding of all these processes could facilitate:

1. making archaeologists more sensitive to the significance and defining role, with regard to ourselves and our knowledge of archaeology, of the non-human and human/social dimension within the 'context of discovery', particularly in terms of studying the material remains of modernity;
2. making the witnesses to the duration of material phenomena and of archaeological accomplishments more sensitive to how much our material reality is entangled with the past and how unique, valuable, irreplaceable and vulnerable this heritage really is;
3. noticing the dangers and potentially preventing certain types of phenomena (often pathological) that can, for example, threaten the historic remains and finding a way to stop destructive, selfish behaviours in the name of maintaining *in situ* the 'material warnings' for future generations;
4. empowering the landscapes and things from the past;
5. targeting archaeological activities and cognitive achievements toward the affirmative, positively, socially causative, including remedial action, such as the reconciliation within the scope of the post-memory of 'invaders' and local inhabitants, a common understanding of the dignity of human remains regardless of their nationality, and coming to terms with a difficult history and accepting a painful inheritance.

The Joachimów-Mogiły War Cemetery: Between Depositional and Pro-social Processes

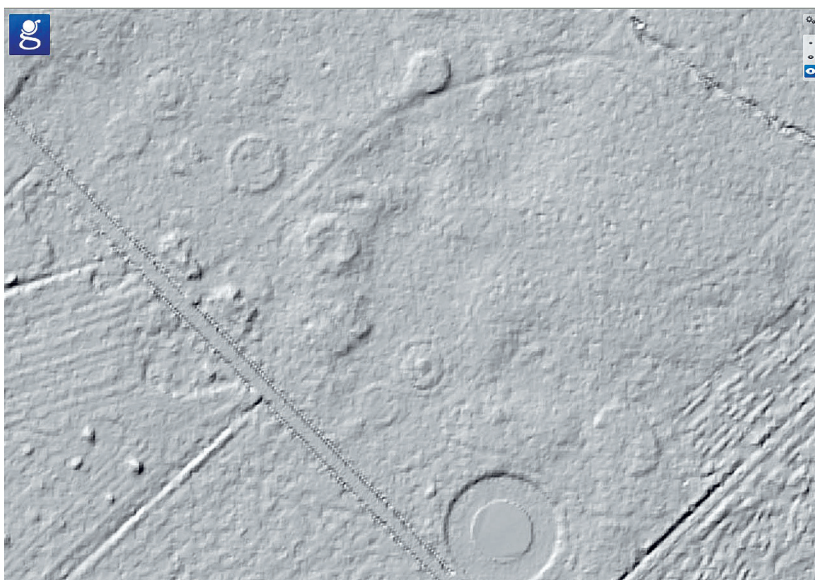
These issues, through which I make general reference to depositional, post-depositional and pro-social processes which took place and continue to take place close to the Rawka River, are explored with reference to a large,



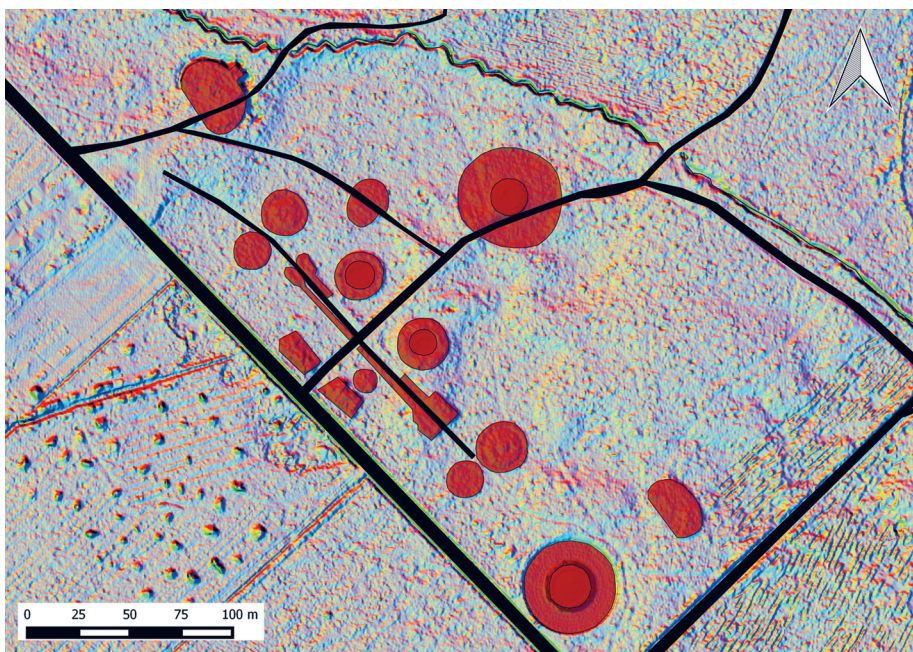
9.6 The interpretative challenge: a photograph signed: 'gr mas ros w m Mogily Skierniewice' (author and date unknown), found in the Archive of the Polish Army Museum, reproduced courtesy of its Principal, Z. Wawer

almost totally forgotten cemetery in Joachimów-Mogily. This is one of many cemeteries on the Rawka and Bzura, but has been chosen as a case study because of its meaningful, palimpsest nature. Until recently the space, covered with dense forest vegetation, was recognised as the 'cemetery' with only a 25 square metre area used for the secondary burial of World War II German soldiers in the early 1990s, and ignoring those resting there since 1915. That act of symbolic violence dominated the whole of the World War I cemetery, whose role in commemorating the dead of 1914–15 was thus elided. Maintenance of the cemetery for the World War II German dead was coordinated and sponsored by German authorities in consultation with the Polish national authorities responsible for land development plans. The rest of the cemetery, 'unknown' and 'protected' by nature in the mainly unmanaged forest, was not fully recognised, even by the land owners, the forest service of the State Forests.

Initial findings from examination of the ALS visualisations were stimulated by the discovery of four photographs in the Archive of the Polish Army Museum. These depicted mysterious 'Russian mass graves in Mogily' (Figure 9.6), which prompted analysis of the terrain itself without much constructive result. However, free access to ALS data helped us to see and understand more (Figure 9.7), though only low resolution data were available free of charge. Subsequently, we acquired more extensive ALS data that provided visualisations that gave us a clearer picture of the materiality of the 'Mogily Cemetery' today (Figure 9.8) and this raised further questions.



9.7 Visualisation of Joachimów-Mogiły War Cemetery from ISOK (Informacyjny System Ochrony Kraju – Information System for the Protection of the Country), part of the publically accessible lidar product, which is available not only to archaeologists but also to militaria hunters/detectorists



9.8 The advanced ALS visualisation of Joachimów-Mogiły War Cemetery, with marked objects interpreted as the resting places of Polish, German and Russian soldiers from World War I. Source A. Zalewska: concept and G. Kiarszys: visualisation. © Project APP

We now assume that the cemetery was originally founded in 1915 and then was magnified in many stages – especially during the period of most intensive re-burials between 1916 and 1917, when many of the wartime cemeteries were relocated. Since most such burial sites were in the territory of the former General Government of Warsaw, works in this area took the longest and were never fully completed. In the General Government's area as many as 245,000 bodies were found, of which 88,000 were identified as German soldiers and 157,000 as Russian. The unit responsible for the burial of German casualties in the former district of Skierniewice was the 2nd Landsturm Infantry Battalion 'Gleiwitz', whose soldiers supervised and organised the work of burial units of a local workforce (Szczepański 2012). Probably also in Mogiły much of the work was done by women, even teenage children. Their descendants, who include the present residents of Wola Szydłowiecka and other villages around Bolimów, recall this work as a gruelling and horrific experience, so much so that it marked the local population with a lasting and strong aversion not only to the former partitioners and future occupiers, but also towards the material remnants of World War I itself. That, to some extent, can also explain the present attitude toward those remains, including acts of vandalism and an unwillingness to uncover and represent them or even acknowledge their presence.

The damaged villages, fields and forests, silent witnesses of the events in 1915, slowly returned to normal until the 1930s. At this time German authorities exhumed the scattered, by then mostly derelict World War I cemeteries, collecting human remains in places such as the mausoleum in Joachimów-Mogiły. Permanent commemoration built in rock and cement extended over a tenth of the original complex, which in the course of the following decades sank into nearly complete oblivion. In interviews, local people quite often recall the time 'just before the last war', when the Germans 'forced people' to exhume 'their cemeteries', but were not interested in exhuming Russian graves, which 'they left to destruction, which is sad since on both sides were so many of our boys' (pers. comm. from a resident of Wola Szydłowiecka aged 86). It should be stressed here that around three million Poles, in many cases forcefully drafted, fought on all frontlines, including the Eastern Front. Many of their names can still be read on gravestones in 'German cemeteries' (which is also for some a source of tension) close to the Rawka and Bzura Rivers.

A half-century of fading memories of war saw the level of the 'collective' and 'collected' awareness of gas attacks in that area almost disappear. In 1978, the artistic endeavours of Wiesław Sokołowski and Jaga Słowikowska could be said to initiate a period of once again remembering the gas attack victims. The mausoleum, by then partially submerged in water, became the arena for artistic spectacles of remembrance, the first one titled 'Imagination as the Boundary of Fear' (1978), the second 'Bolimów Mystery' (1980). Accompanied by solemn music from Krzysztof Kaczmarek, thousands of candles were lit alongside geometrical figures symbolising the gas attacks. When asked about what inspired the project, the artists mentioned 'contact with the place itself

and the mysteriousness of it' and the ground-breaking reading of the passage from 'Lazarus' by Andre Malraux (1977) about the gas attack in 'Bolgako' identified by them as Bolimów. One of the recurring lines accompanying the performance was the poem:

Homeland
is a great indifference
of graves
smokes explodes
rises in
the abyss of silence
(Sokołowski 1978)

The artists still mention this experience as very important for them, revealing their artistic and purely human point of view. They say (pers. comm. 2014), that for the local population, especially the young people, it was often the first opportunity to learn that so many anonymous Polish soldiers are lying around us, in this great cemetery on Rawka and that 'before Ypres there was Bolimów' (Rymuszko 2001: 54).

However, after those events the Joachimów cemetery, as many others in the area, remained totally neglected until 1993, when the bodies of World War II German soldiers were relocated to a ruined and only partially visible World War I cemetery in Joachimów-Mogiły. Furthermore, Soldatenfriedhof Joachimów-Mogiły was designated as a commemoration site dedicated to 5,156 soldiers whose bodies have never been located. Thus, the military cemetery at Joachimów-Mogiły became the final resting place of two generations of German soldiers who died on Polish land.

Sadly, the efforts to commemorate 7,722 soldiers killed during World War II overshadowed any concerns for the memory of those buried there before, the soldiers of World War I. The official granite commemorative plaques lack any mention of the men killed in the earlier war and who are also buried there (Figure 9.9). Until 2014, the only trace of their presence was a single primitive cement plaque placed on the mausoleum cross on the initiative of Andrzej Lewandowski, a private person. It bears a cross and an inscription reading: WAR CEMETERY 1914.15.

My view of this situation may seem blunt, but I believe that all the soldiers (German, Polish, Russian) buried in Joachimów in 1914–15 were killed twice. Once by bullets, shrapnel, gas or disease, and then again by oblivion, neglect, thoughtlessness, short-sightedness, lack of goodwill or concern for the dignity of human remains. Then again, maybe also by the overwhelming excess of death, pain and misery that permeated this particular war and post-war landscape; by the excess of human 'post-memory', which seeks retribution (or is individual denial) against the material remnants of that which had been so painfully experienced in the past in this very place, and which therefore deserves the denial, neglect, obscurity it receives (concealed by something that may be equally painful, but that pain is less locally rooted).



9.9 Entrance to the War Cemetery showing the inscription which reads (in German and in Polish): 'GERMAN WAR CEMETERY JOACHIMÓW MOGIŁY 1939-1945'. Source author

Today, the soldiers buried in Joachimów War Cemetery are 'absent present'. Those buried there during and after World War I seem absent in more than one way, while animosities and misunderstandings still circulate around the cemetery. However, there is now hope of a breakthrough.

A New Opening Scene: Cognitive and Pro-social Processes based on Visualisations of ALS data (LiDAR)

Visualisations of ALS data are gradually becoming one of the most persuasive and as such causative representations of landscape (Rączkowski and Banaszek 2014). That they are cognitively invaluable can be shown by the discovery of the forgotten wartime cemetery in (Joachimów-)Mogiły and by the complexes of no man's land in Bolimów Landscape Park. They are also suggestive and socially instrumental, and it was thanks to ALS data that we were able to halt deforestation and deep ploughing in areas particularly rich in World War I remains. Although an official decision on the future management of the landscape around the Rawka and Bzura Rivers is still pending, the interpretations and representations of those visualisations are playing a crucial role not only in purely cognitive but also in pro-social processes.

Thanks to the ALS visualisations, the completeness, uniqueness and scale of trenches and thousands of dugouts on the surface of the former battlefield landscape are easier for decision makers and residents to understand, helping to make the case that they are worthy of conservation.



9.10 The Eastern European Gas-scape near the Joachimów-Mogily Cemetery, close to former no man's land, with a robbery pit in the foreground (2012). Source author

However, the ALS visualisations can also prove risky from a conservation point of view. Since products of ALS data have recently been made publically accessible in Poland within the framework of the ISOK Project (data collected by the Main Geodetic and Cartographic Documentation Centre, originally for creating flood areas and risk maps) – they are used now also by metal detectorists and grave robbers to map out potential targets. The risk of damage to the conflict landscapes is becoming ever more apparent (Figure 9.10) with potential for misuse/abuse of archaeological research results, particularly by battlefield scavengers and militaria souvenir hunters (Zalewska 2013). Indeed, there is ample evidence, both material (first-hand observations of holes, illegal digs and so on) and verbal (comments on Internet forums and in community newsletters where the topic is often discussed), suggesting that this group is already fully aware of the benefits of ALS, which is particularly worrying given the evidence of interference already known at sites, damage to which may have serious far-reaching consequences. When such concerns are publicly voiced, I tend to hear that it is impossible to monitor huge forested areas, while the representatives of the Head Office of Geodesy and Cartography and other civil servants responsible for the publically available ALS data maintain that we must not limit access to data generated from public funds. Thus, facing the next years of the survey in the framework of a project titled ‘Archaeological Revival of Memory of World War I: Material Remains of the Life and Death in Trenches of the Eastern Front and the Condition of the Ever-changing Battlescape in the Region of the Rawka and Bzura (1914–2014)’, planned for 2014–18 and funded by the Polish National Centre of Science (NCN- SONATA BIS no. 2013/10/E/HS3/00406), I will trust to the assumption rooted in the Rawka region by H.M. Wennrich (1935: 77):

Landscape is a force.

It imposes its laws even onto such powerful phenomena as war – it shapes war, particularly positional war. High in the mountains, on the bare rock, it will be very different than in the lowlands, and different still in marshlands. Military principles, the use of weaponry and other tools of war must be adopted to the landscape.

Landscape shapes people and their way of life, it grants depth and defines specifics because it is something lasting, centuries old, something that has been the witness of each subsequent generation’s passing. Any changes it may endure through ploughing, sowing or harvesting in the fields, or collecting wood in the forest are all reasonably regulated; their impact upon the entirety of the landscape is no greater than that of a human breath.

References

- Borodziej, W. and M. Górny (2014) *Nasza wojna. Tom I. Imperia 1912–1916*. Warszawa: Grupa Wydawnicza Foksal.
- Daszyńska, J. (ed.) (2011) *Operacja Łódzka. Zapomniany fakt I wojny światowej*. Łódź: Księży Młyn.

- Де-Лазари А. Николаевич (1935) Химическое оружие на фронтах мировой войны 1914–1918 гг. Москва: ГВИ.
- Dunker, H. and H. Eisermann (1927) *Das Infanterie-Regiment v. Kluck (6. Pomm.) Nr. 49 im Weltkriege 1914–1918*. Liegnitz: H. Krumbhaar.
- Górny, M. (2014) Niezbyt Wielka Wojna (A Rather Small War). *Heritage* 16: 36–43.
- Hoffmann, M. (2013) *Wspomnienia. Wojna wśród niewyzyskanych sposobności* (orig.: *Der Krieg der versäumten Gelegenheiten*, Verlag für Kulturpolitik, München, 1923). Oświęcim: Napoleon.
- Kaliński, S. (2010) *Ataki gazowe w bitwie pozycyjnej 9. Armii Niemieckiej nad Rawką i Bzurą 1914–1915*. Przemyśl: Fort.
- Kramer, A. (2007) *Dynamic of Destruction: Culture and Mass Killing in the First World War*. Oxford: Oxford University Press.
- Ludendorff, E. (2014) *Moje wojenne wspomnienia, cz. 1: 1914–1916* (orig.: *Meine Kriegserinnerungen. 1914–1918*, Ernst Siegfried Mittler und Sohn Verlagsbuchhandlung, Berlin, 1921). Warszawa: Tetragon.
- Malraux, A. (1977) *Łazarz* (orig.: *Lazare*, Editions Gallimard, Paris, 1974). Warszawa: Państwowy Instytut Wydawniczy.
- Rączkowski, W. and J. Banaszek (2014) Potencjał danych ALS w badaniach archeologicznych. In P. Wężyk (ed.) *Podręcznik dla uczestników szkoleń z wykorzystaniem produktów LiDAR*, pp. 192–200. Warszawa: ProGea GUGiK.
- Rohkohl, W. (1923) *Reserve Infanterie-Regiment 226*. Oldenburg, Berlin: Verlag Gerhard Stalling.
- Rymusko, M. (2001) Trzynasty Krąg Sokoła. *Nieznane światy* 131: 52–9.
- Saunders, N.J. (2011) First World War Archaeology: Between Theory and Practice. In F. Nicolis, G. Ciurletti and A. De Guio (eds) *Archeologia della Grande Guerra*, pp. 37–53. Trento: Atti del Convegno Internazionale 23/24 June 2006.
- Schiffer, M.B. (1987) *Formation Processes of the Archaeological Record*. Albuquerque, NM: New Mexico University Press.
- Szczepański, J.E. (2012) *Landsturm w Generalnym Gubernatorstwie warszawskim 1915–1918. Formacja głębokich rezerw*. Warszawa: Oficyna Wydawnicza 'Ajaks'.
- Umiastowski, R. (1933) *Wśród trujących mgieł. Opowieści o wojnie gazowej*. Warszawa: Główna Księgarnia Wojskowa.
- Urbańczyk, P. (1981) O możliwościach poznawczych archeologii. *Przegląd archeologiczny* 29: 5–52.
- Wennrich, H.M. (1935) *Das Reserve-Jäger-Bataillon Nr. 21 im Weltkriege*. Zeulenroda: Verlag Bernhard Sporn i.
- Zalewska, A. (2013) Relevant and Applicable Archaeology: The Material Remains of the First World War: Between 'Foundational' and 'Biographical' Memory, between 'Black Archaeology' and 'Conflict Archaeology'. *Sprawozdania Archeologiczne* 65: 9–49.
- Zalewska, A., S. Kaliński and J. Czarnecki (2014) *Wielka wojna nad Rawką 1914–1915 i materialne po niej pozostałości*. Warszawa: Wydawnictwo Archeologii i Etnologii PAN.



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Remembering Uncertainty: The World War II Warscape of the Australian Northern Territory

Keir Reeves, Birger Stichelbaut and Gertjan Plets

Abstract

On 19 February 1941 Japanese bombers struck Darwin. This raid did more than merely destroy Australia's small provincial capital. It resulted in the militarisation of the largely pristine 'outback' stretching out over 2,500 kilometres between Darwin and Alice Springs. Untouched by modern development, large numbers of relics to this turbulent part of Australian history remain preserved today. Despite the fact that the bombing of Darwin and subsequent raids are an integral part of the collective memory of the Northern Territory and broader Australia, only a small amount of these war relics are known and interpreted for visitors. This chapter evaluates the potential of remote sensing data for documenting war heritage in the Northern Territory of Australia. Preliminary insights presented here not only underscore the huge potential of historical aerial photographs, they also illustrate the materiality of the transformations enacted by the Darwin bombings. In addition these first mappings indicate that heritage preservation initiatives are highly selective. These relate to direct experiences of communities living around the former military bases and recent efforts of the Australian government to overcome the peripheral socio-political setting of Darwin and position it closer to the urban southwest part of the country.

Keywords: Australia, Darwin, World War II, military landscape, logistics, selective remembrances.

Introduction

This chapter explores the potential of historical aerial photographs for the study of heritage related to the war in the Pacific. Our study demonstrates the wealth of available aerial photographs and the extensive heritage surviving



10.1 Aerial photograph of downtown Darwin in 1944. Source National Library of Australia, Aerial Photograph Collection D 52 4 32

in the landscape and attempts to open up the historical narrative which mainly focused on the Japanese bombing raids and aerial defence of the city of Darwin.

Early in the morning of 8 December 1941 Australian Prime Minister John Curtin solemnly addressed the nation, stating 'we are at war with Japan'. During his speech Curtin reassured the nation that it was preparing for the war and that Joe Gollings, the Minister for Interior, was *en route* to Darwin (Northern Territory) to coordinate preparation for the hostilities (Curtin 1941). Less than three months later (19 February 1942) it fell to Australia's stoic war-time Prime Minister to inform the nation that Darwin (Figure 10.1)

and parts of the Northern Territory had been bombed by the Imperial Japanese Navy, inflicting extensive damage to the remote provincial capital and its surrounding landscape.

On the morning of 19 February 1942 a group of 152 Japanese planes took off from four aircraft carriers followed by land-based bombers and headed for Darwin. At 09h58 the first bombs were dropped. By 10h30 this first wave attack was over, leaving large parts of the town in ruins and causing approximately 243 casualties. A second strike in the afternoon hit the Royal Australian Air Force (RAAF) base east of the town. According to the Defence of Darwin Experience 683 bombs totalling 114,600 kg of explosives were dropped. Although this was by far the most deadly attack on Australian soil throughout the war, Japanese bombers continued to terrorise the northern parts of Australia, leaving communities in uncertainty and damaging public morale. According to the Australian War Memorial a total of 97 aerial raids attacked northern Australia (Australian War Memorial 2014).

While the of approximately 243 casualties is relatively small in comparison to other concurrent battles in Europe, Africa and the Pacific, the momentous Darwin bombings proved essential in rallying the public and in legitimating Australia's war efforts. Soon after the attacks the bombings became an integral part of the collective memory of the region, and over the past three decades, coinciding with the revival of the Anzac tradition, it has increasingly become part of the national narrative of Australia (Roberts and Young 2008, Powel 2013). The immediacy of the conflict, the state of unpreparedness and huge uncertainty in the immediate aftermath of the conflict ensured that it was perceived as an 'invasion', profoundly shocking the young nation (Powel 2013). Although there are claims that the seriousness of the conflict was exaggerated, both during and after the war, in order to foster the creation of social memory and negotiate national cohesion (Roberts and Young 2008: 67, Stanley 2005), one image remains crystal clear: in 1942 the war came to Australia. And in contrast to Australia's participation in World War I, now Australia had its own home front, fought on its own soil and had a flexible and mobile enemy that could strike at any time. Because of the nature of the raids and unpredictability of the enemy, the air war was, and still is, especially remembered as a period of uncertainty.

While the Darwin bombings were the first and most devastating of the Japanese aerial attacks on Australia, the raids over northern Australia would continue until November 1943. The bombings and the Australian responses not only highlighted how unprepared for the war Australia was, but also the historically embedded marginality of the Northern Territories in Australia (see Roberts and Young 2008 for the current liminal setting of Darwin). They also clearly illustrated the need to develop telecommunication infrastructure connecting Darwin with the major urban centres in the southeast of the continent.

The immediate response of the Australian government was the massive militarisation of the Northern Territories. Not only were all non-essential inhabitants evacuated, an impressive network of defensive infrastructure was

laid out in Darwin and throughout north Australia. Tens of thousands of Allied troops were brought in and airfields, military bases, hospitals and logistical support infrastructure were developed predominantly along roughly the first 1,500 kilometres of the Stuart Highway. This previously un-asphalted dirt track between Darwin and Alice Springs quickly became north Australia's lifeline. As it transformed into an important asphalted transport corridor it drastically reshaped Australia's northern landscapes (Pearce and Alford 2006: 9). Despite some minor infrastructure development (resource extraction and recent extensive renovation of both the railway and parallel highway) and the encroachment of north Australia's famous 'bush' vegetation, most of the infrastructure is still preserved today. Numerous airstrips, radio tower foundations, semi-standing ruins, gun emplacements and artillery posts survive as relics to one of Australia's most turbulent times.

Over recent decades the Darwin bombings have increasingly become an integral part of Australia's cultural memory, and many sites in and around Darwin serve as mnemonic touchstones embodying hardship and uncertainty during the 'dark period' of World War II (Rechniewski 2012, Roberts and Young 2008). Along with the enduring memory of Cyclone Tracy on Christmas Eve 1974 the bombing frames popular understandings of the remote location of Australia's northernmost state capital and its precarious existence throughout the twentieth century (Roberts and Young 2008). Although the commemoration of the raids has been contentious because it corresponds to a certain extent to the broader 'Great Australian Silence' in Australian historiography (Riseman 2012), under-representing the Indigenous voice, over the last decade important efforts have been made to draw attention to the bombings and interconnected sites (Rechniewski 2012, Roberts and Young 2008). Roberts and Young (2008: 57) argue the specific memorialisation of the bombing and Australia's 'frontline' narrative expanded especially during the mid-2000s, coinciding with the already popular interest in Australia's war narratives (Powel 2013), and connected with attempts by the government to reduce the isolation of Darwin and the Northern Territory from Australia's urban centres. This interest in commemorating Australia's World War II 'frontline' went hand in hand with some well-directed and well-funded heritage initiatives. Although the 'Defence of Darwin' interpretation centre opened in 2012 as the centrepiece of this recent memorialisation drive, funding was also directed towards preserving and presenting certain sites in the vicinity of Darwin. The frontline narrative is extremely pressing today as Darwin remains an important outpost for the US and Australian Army in light of new geopolitical threats in Asia. Besides more or less politically influenced national commemoration practices, for many inhabitants in the sparsely populated outback certain material remains are an integral element of their cultural heritage. As some local preservation initiatives, local information panels (Figure 10.2) and key informant interviews hint, the warscape of the northern bush landscape firmly constitutes regional identity in north Australia.



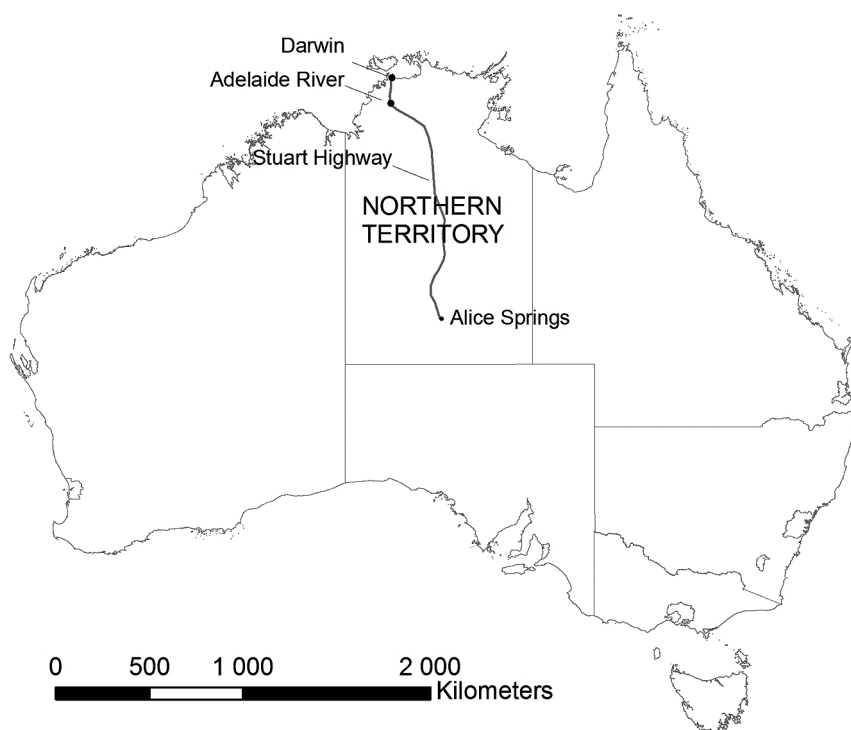
Although the Darwin bombings are well studied from an historical point of view and major sites have been made accessible to the public, the entirety of the impact of World War II on the landscape in the Northern Territories remains relatively under-explored (Dermoudy 1984: 2). Only large sites in the immediate surroundings of Darwin are managed, made accessible to the public and are equipped with modern interpretative infrastructure. The hundreds of small and large sites in the extensive landscape surrounding Darwin, however, have been relatively forgotten and remain – apart from some fairly abstract descriptions in local historical works – largely undocumented in a systematic way.

10.2 A new government-funded interpretation panel near Darwin (left) and an older private heritage initiative (right) in Adelaide River. © G. Plets

State of Research in the Northern Territory

The recent efforts to manage, document and present the material remains of World War II did not come out of thin air, just because the Darwin bombing narrative served a particular sociological project. On the contrary, the region (see [Figure 10.3](#)) has a long history of investigation, especially by local researchers and heritage enthusiasts. Important steps towards heritage documentation and management have already been set since the early 1980s.

10.3 Map of Australia marked with key sites referred to in the text. © authors



At this point an initial survey of military heritage in the Northern Territories was commissioned, aimed at developing conservation strategies and management plans. The general expectation was that besides well-known and large structure sites, such as the military airstrips along the Stuart Highway, East Point Military Area and Snake Creek ammunition dump, few new sites would be encountered (Dermoudy 1984: 2). The preliminary surveys, however, revealed a diversity of sites that had never before been recognised or investigated in the region. The researchers responsible for the survey concluded in their report that 'a gross underestimation had been made of the richness of military heritage in the Northern Territory' (Dermoudy 1984: 2). Besides the anticipated large airfield sites and ammunition storage facilities, to the surprise of the surveyors, a myriad of other sites were discovered including radar installations, antenna bases, defensive points on the beaches, dams, bunkers, but also rifle and rocket ranges, aircraft crash sites and a range of logistical sites (Dermoudy 1984: 2). In 1998 the National Trust of Australia acknowledged that there are 'few sites of historic and heritage significance in the region that could be accurately plotted in light of lack of any detailed surveys' (National Trust of Australia 1998: 1).

Although these initiatives were important pioneer work, much of the basic steps of heritage management such as the identification and recording of features and sites at a landscape scale are still urgently needed. In addition there is almost no attention on broader landscape setting, spatial distribution

and enduring social meaning. The main problems encountered in the past are the large areas to be covered (the logistical landscape extends for 1,500 kilometres along the Stuart Highway) and the remoteness of the outback environment, long grass, dense (tropical) vegetation and over 60 years of overgrowth create difficult field survey conditions (Dermoudy 1984: 19).

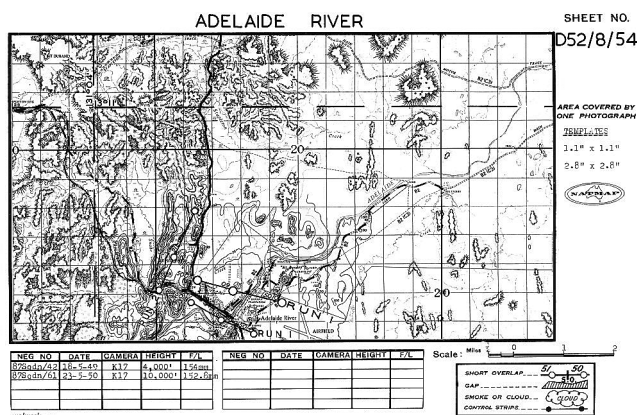
Historical Aerial Photographs in Australia

Contrary to many European countries, Australian archaeology and heritage studies have no strong research tradition using aerial photographs in the study of the cultural landscape (Jones 1996: 25). When they are used, it is mainly historical photographs that provide a general landscape context and location of sites only. Generally speaking, aerial photographs are considered of less interest because predominantly Aboriginal remains are not visible from the air.

However, millions of historical aerial photographs of Australia are available through various archives and are an underexploited source of information for historical archaeology and the study of colonial historical landscapes. This is especially true where they provide information about a landscape largely left untouched by infrastructure development, urban sprawl and resource extraction, which has affected large parts of Australia.

One of the main challenges is to locate relevant aerial photographic coverage. Within the international aerial archaeological community little is known about the main historical archives covering these parts of the world. Archival research established that there are large aerial photographic archives in Australia. Both the Northern Territory Department of Lands, Planning and the Environment (2015) and the Northern Territory State Library hold some readily accessible collections of aerial photographs of the region, some of it online. Furthermore extensive nationwide aerial coverage for specific periods is available at the National Archives of Australia (2014). The most relevant series are contact prints (160 m of storage shelves) of vertical and oblique 'Australian Army aerial photographs of Australia' (series number A8414). The earliest photographs date from 1933 and an index, based on the 1:63,360 topographic map series, is available. The second large resource is the 'Aerial survey photographic prints' collection (series number A1579) at the Australian National Archives, holding 243 metres of shelves containing prints dating between 1940 and 1960. However, accessing these collections is not straightforward because the retrieval process (including manual assessment of the contents of boxes to make sure no inappropriate material is made available to the public) can take up to several weeks. More historical aerial photography is available at the National Library of Australia's map department (2014), which holds approximately 600,000 aerial photographs of Australia with a date range of 1928 to 1987. This collection is accessible through binders with flight diagrams (for example [Figure 10.4](#)),

10.4 Example of a flight diagram. Source National Library of Australia, Aerial Photograph Collection D 52 8 54, Flight diagram 'Adelaide River 1942'



which are ordered by map sheet references of the 1:63,360 topographic map series and ensure that time series of the same area are kept together. The diagrams show the flight line, date, number of photographic runs, and number of prints, sometimes complemented with flying height, focal length and scale. For many areas in the Northern Territory several time series are available especially when it concerns areas of interest to the military.

This wealth of information opens up a series of new approaches to the discovery, understanding and contextualisation of traces of World War II at the 'top end of Australia'. The availability of extensive aerial coverage allows large blocks of ground to be covered and supports a refocus from a site-oriented approach to a landscape scale. The potential of historical aerial photographs is currently not being exploited in the Northern Territory and to date aerial photographs are only used to illustrate damage from the bombings rather than a primary source of information in their own right. In addition to this they provide contemporary records of the development of the military landscapes and provide a rich and textured view into the past.

Adelaide River Case Study

BACKGROUND

Following preliminary site visits in December 2014 a research area near Adelaide River, a small township 110 kilometres south of Darwin, was selected as a pilot study to explore the potential to investigate the war heritage in the Northern Territory of historical aerial photographs. Most major sites in Adelaide River are located close to the Stuart Highway and are easily accessible. A self-guided 'WWII heritage trail' enables tourists to visit some of the sites (bunker complexes, foundation remains of a railway depot, cemetery and so on) close to the town and both the railway museum and local pub provide very general information about some World War II objects in the town. However, in contrast to the initiatives around Darwin, many of the sites around Adelaide River do

not even have basic interpretative infrastructure or management plans. At these sites it is as if the war stopped only a decade ago. Rusty 200 litre oil drums, cars and military equipment are scattered though the former camps. Richard Luxton, a local heritage enthusiast and land owner on which the 'Coomalie airstrip' (see also Shanahan 2014) is located, stressed that it is very difficult to get basic funding and support from the government because many World War II sites, including major airstrips such as Coomalie, on private lands, fall outside current legislation. Hence, any preservation effort is largely dependent on the interests of the owner, local enthusiasts or local governments.

Archival research in the Australian National Library produced a comprehensive dataset of 57 historical aerial photographs of the region dating between 1936 and 1949. The swift landscape dynamics and development of the town and the heritage in the surrounding are evident in these time series. Each set of images comprises overlapping coverage and all available photographs were orthorectified and georeferenced using Agisoft PhotoScan 1.1.0 (see Plets et al. 2012 for workflow) and all relevant features were digitised in ArcGIS 9.3. The end product is a detailed GIS-inventory of all features which were constructed in the area during World War II. The landscape mapping proved to be challenging because of the limited numbers of ground control points that could be identified on the historical photographs.

EVOLUTION OF THE CONFLICT LANDSCAPE AND HISTORICAL CONTEXT

The first available aerial photographs (1936) depict Adelaide River as nothing more than a few isolated buildings along the North Australia Railway (Figure 10.7). The development of the area started slowly in 1939 when it was designated a military farm and rest camp (Northern Territory, Department of Lands, Planning and the Environment 1999: 24).

The 1941 photographs show a dramatic increase in the infrastructure and the developments prior to the Darwin bombings. At three locations military camps were erected in new areas. Railways sidings provided storage facilities for ammunition, fuel and military goods. East of Adelaide River an airstrip was constructed in 1940 as an Advanced Operational Base and continued to be used as a training airstrip during the remainder of the war (National Trust of Australia 1998: 10). By the end of 1941, Adelaide River had grown into a relatively large military base. After the Darwin bombings, development accelerated when it became one of the most important military centres in the Northern Territory, housing American forces and the Australian Army, Navy and Air Force (National Trust of Australia 1998: 10). Many of the troops and personnel moved from Darwin to the Adelaide River area because it was more easily defensible than the exposed harbour town. Suddenly located at Australia's 'frontline of defence' Adelaide River quickly transformed from a marginal railway stop into an enormous military complex. The next series of photographs dates from 1942 and effectively shows the full extent of the military build-up. The exact date for the series is unknown but the flight probably took place around July–August 1942 since it shows the preparatory works for the construction of Adelaide River War Cemetery (Figure 10.5 A)



10.5 Australian aerial photograph depicting the area immediately north of Adelaide River Township in 1942. National Library of Australia, Aerial Photograph Collection D 52 8 54, flight no. 256/1, photo VX220

which was begun in August 1942 (Alford 1996: 11). The aerial photographs show a clear division of the cemetery into a civilian and military burial plot.

In early 1942 a former cattle-handling railway siding was upgraded to allow hospital trains to arrive (Dermoudy 1989). This led eventually to the development of Number 119 Australian General Hospital 2 kilometres northeast of the town in March 1942 (Figure 10.5 B). South of the river agricultural fields related to the military farms are evident (Figure 10.5 C) and just south of the fields the remains of a work camp for Indigenous Australians who were evacuated from the coastline areas can be seen (National Trust of Australia 1998: 12) (Figure 10.5 D).

The next time series dates from 1945 and provides a similar view with more military camps and extensions of already existing sites. Furthermore the area cultivated by the Army farms almost doubled and is probably a sign of hard conditions in the territory.

Two groups of photographs are available for 1949 and are particularly interesting because they show the post-war situation of the town centre and



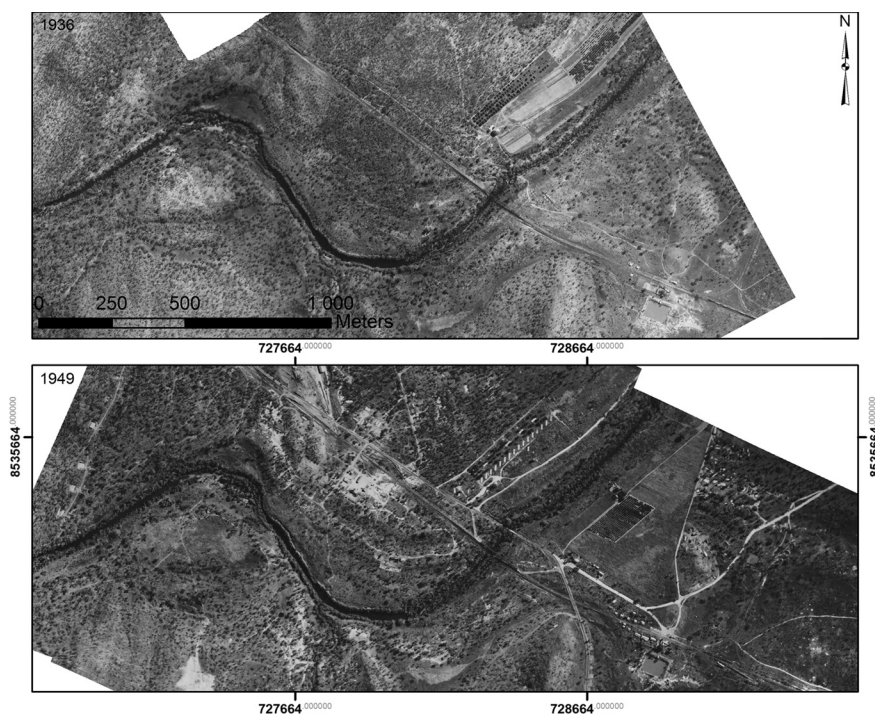
provide a detailed insight into the Snake Creek Explosives Storage Depot (see below). Following the end of World War II the military withdrew from the area and the evacuated civilians eventually returned to the area (National Trust of Australia 1998: 12). Many of the barracks and huts had been removed by 1949, leaving nothing but concrete slab foundations ([Figure 10.6](#)).

Snake Creek

A particularly interesting site in the Adelaide River area is at Snake Creek, approximately 2 kilometres northwest of the town. The construction of an extensive Navy ammunition depot at this location was ordered on 22 April 1943 (Dermoudy 1984: appendix IV) with construction starting towards the end of the year. The location was favoured above existing Navy stores in Darwin because the latter were more exposed to attack. The Snake Creek Explosives Storage Depot was built on the eastern face of a steep ridge, with a railway spur following the natural contours of the landscape ([Figure 10.8](#)). The site consisted of laboratories, a work settlement, railways spurs and loading platforms. Large ammunition bunkers were quarried into a ridge (Dermoudy 1984) or built in above-ground camouflaged concrete bunkers. The construction of the site progressed slowly and the facility was only in use at the end of the war.

Snake Creek remained in use after the war by the Royal Australian Air Force and the Navy before it was handed over to the Northern Territory

10.6 Typical surface remains, artefact scatter and concrete slab foundations near Adelaide River. The location of this site is indicated at [Figure 10.10 D](#).
© B. Stichelbaut



10.7 Comparison of the 1936 and 1949 orthophotos illustrating the rapid landscape change. Source National Library of Australia, Aerial Photograph Collection D 52 8 54. Top: flight no Eagle 68, photo 9,975. Bottom: flight no 8,754, photo 15



10.8 Snake Creek Explosives Storage Depot in 1949. Source National Library of Australia, Aerial Photograph Collection D 52 8 54, flight no 8.754/42, photo 21

Government in 1979. In the post-war period it was also used as a storage facility for Uranium ore from the nearby Rum Jungle mine. The lands where the site is located are also of heritage importance to the traditional owners of the area, the Kungurrakan and Awarai people (National Trust of Australia 1998: 4).

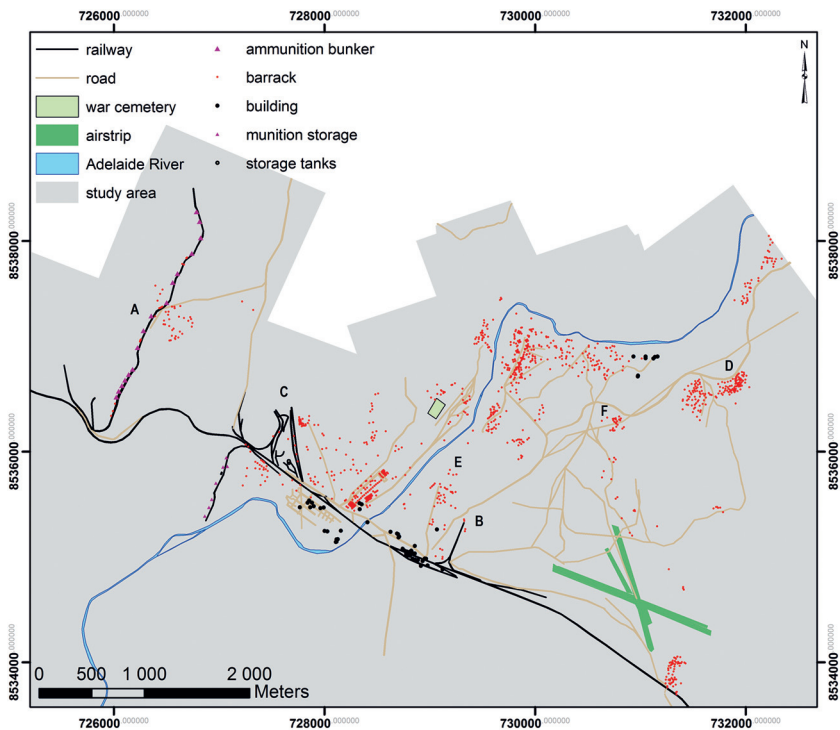
The site is a good example of the rapid deterioration of the war heritage in the study area. Although it can be argued there is little threat to the environment due to limited land development, the preservation of sites is rapidly worsening. This is clear when comparing the present-day preservation of the Snake Creek ammunition depot and its condition in 1984 (Dermoudy 1984: 11). Thirty years ago the site was described as ‘a first class tourist attraction ... visited by all the major tourist operators in Darwin’ (Dermoudy 1984: appendix IV p. 11) and the presence of timber-framed storage buildings was considered unique. In 1990 it was still considered ‘the best example of in situ evidence of Adelaide River Township’s high profile during WWII’ (Dermoudy 1990: 16). However, deterioration was still evident, as in 1983 41 standing buildings remained, but less than a decade later only 28 could still be identified (Dermoudy 1990: 2). Today the deterioration is even more dramatic, and the site is no longer signposted and can only be accessed along an abandoned and difficult dirt track. It was visited during fieldwork because of the extensive remains which are visible on Google Earth imagery. According to local heritage enthusiasts more damage has occurred to the site over the last 30 years than in the years after the end of World War II (R. Luxton pers. comm.). Although the material remains of the ammunition stores and railways are impressive, the present site is neglected. There is only one large building standing, and all others have been demolished, vandalised or removed with only the concrete floor slabs remaining (Figure 10.9). This highlights the need for a broader vision on the war heritage in the Northern Territory. The sites near Adelaide River clearly did not benefit from commemoration of the seventieth anniversary of the end of the war and renewed touristic interest in the war heritage around Darwin.

GIS MAPPING

Although the area studied is only a small part of the military landscape between Darwin and Alice Springs, these first results are promising and demonstrate the need for large area survey. The GIS mapping reveals the spatial pattern of the military bases and over 1,000 huts, tents, bush timber constructions and barracks were recorded (Figure 10.10). Besides a large density of features there is also a wide range a sites detected ranging from the war cemetery to Army farms, hospitals, military camps, railway siding, ammunition dumps and airstrips. The spatial pattern suggests an organic structure based on *ad hoc* decisions. The preliminary site visits indicated material remains scattered throughout the area.



10.9 Remains of an ammunition bunker at Snake Creek Explosive Storage Depot in December 2014. © B. Stichelbaut



10.10 GIS mapping of the conflict landscape. A: Snake Creek ammunition storage area, B: 119 Australian General Hospital, C: hospital train railway sidings, D: military camp with extensive material remains, E: Army farms, F: High-Frequency Direction Finding Antenna base. © authors

Conclusion

This landscape analysis of Adelaide River strikingly illustrates how a minor surprise attack triggered a militarisation process that left huge marks on the landscape. In other conflicts such as the Western Front of World War I there is a growing realisation that as time passes the heritage of a war is no longer vested in the memories of people but rather in the landscape that remains as 'the last witness' (see [Chapter 17](#)). This pilot study, focusing on a small research area along the 1,500 kilometres long defence line, points at the potential of the adaptation of this concept to a different context: a rich archaeological landscape peppered with hundreds of small and large material remains, serving as the only relics of Australia's involvement in World War II. Just as many other contributions to this book illustrate, historical aerial photographs, because of the density and vastness of the landscape, are a unique source to map and understand the dynamics of conflict landscapes. This case study of the World War II heritage of north Australia opens up the potential for broader research into conflict heritage in the Pacific region. For this, existing historic photographic archives have a crucial role in enabling the scientific study of the impacts of the war, and the systematic survey of the hundreds of battlefields across the Pacific, providing the tools for management decisions.

This case study illustrates that, although there are thousands of individual objects scattered between Darwin and Alice Springs, management is highly selective. This is of course true for cultural heritage management generally, which is generally selective in what is dealt with, but in the Northern Territories there is a strong emphasis on Darwin and its immediate surroundings. Outside Darwin, management and site interpretation is dependent on local enthusiasts or initiatives, such as in Adelaide River where the inhabitants still remember this episode as a period of uncertainty, which is an intrinsic part of their regional identity. Although such initiatives should be applauded, their scope and effectiveness remains limited. First, as highlighted in the case of Adelaide River, only a limited number of sites receive direct attention, and these are in the near vicinity of the village. Major sites nearby, which are an integral part of the conflict landscape and played an important role in the air war, are ignored and are deteriorating. Secondly, many sites are located on private land, and as heritage enthusiast and member of the local heritage board Richard Luxton says, there is no legislative framework for managing the large number of sites that are on private land. The authors suggest that it is imperative that these shortcomings are overcome, and believe that the systematic mapping of all sites is an important first step.

The authors hope to extend this small pilot study across other parts of the Northern Territory, including Darwin, in order to get a better overview of the impact of the war on the extensive landscape of north Australia. In addition to the study of aerial images and mapping the warscape, local perceptions of the bombings will be further investigated. A counter-mapping project (see Harrison 2011) will be set up, contrasting the tangible dimensions of the

archaeological landscape with its intangible associative dimensions. As such we hope to investigate whether or not the selectivity of remembrance and which regional structures and narratives contribute to the construction of an associative cultural landscape.

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References

- Alford, R.N. (1996) *Pilot Study of World War II Sites in the Adelaide River Region of the Northern Territory*. Darwin: National Trust of Australia.
- Australian War Memorial (2014) *Bombing of Darwin 1942*. http://www.awm.gov.au/units/event_59.asp (retrieved 10 December 2014).
- Curtin, J. (1941) *Japan Enters Second World War*. Available through Australia's audiovisual heritage online. <http://aso.gov.au/titles/radio/curtin-japan-second-world-war/clip1/> (retrieved 21 January 2015).
- Dermoudy, P. (1984) *Military Sites Survey: An Interim Report for the Museums and Art Galleries Board of the Northern Territory*. Darwin: Peter Dermoudy.
- (1989) *Down the Track: A Military Buff's Guide to the Stuart Highway*. Darwin: Australian Bicentennial Authority.
- (1990) *Snake Creek Munitions Storage Area: Conservation Plan Prepared for the National Trust of Australia*. Darwin: National Trust of Australia (NT).
- Harrison, R. (2011) 'Counter-mapping' Heritage, Communities and Places in Australia and the UK. In: J. Schofield and R. Szymanski (eds) *Local Heritage, Global Context: Cultural Perspectives on Sense of Place. Heritage, Culture and Identity*, pp. 79–98. Farnham and Burlington, VT: Ashgate.
- Jones, K. (1996) Aerial Photography in New Zealand Archaeology. *Australasian Historical Archaeology* 14: 25–33.
- National Archives of Australia (2014) *Aerial Photographs: Fact Sheet 191*. <http://www.naa.gov.au/collection/fact-sheets/fs191.aspx> (retrieved 10 December 2014).
- National Library of Australia (2014) *Aerial Photographs Collection*. <http://www.nla.gov.au/selected-library-collections/aerial-photographs-collection> (retrieved 10 December 2014).
- National Trust of Australia (1998) *Historic Sites in the Coomalie Region of the Northern Territory / National Trust (NT) for Dept. of Lands, Planning and Environment*. Darwin: Departments of Lands, Planning and Environment.

- Northern Territory, Department of Lands, Planning and Environment (1999) *Signs of History: A Photographic Collection of the World War II Historic Sites Signs in the Northern Territory*. Darwin: Dept. of Lands, Planning and Environment.
- (2015) *Aerial Photography Index*. <http://www.ntlis.nt.gov.au/imfPublic/airPhotoimf.jsp> (retrieved 21 January 2015).
- Pearce, H. and B. Alford (2006) *A Wartime Journey: Stuart Highway Heritage Guide*. Darwin: Northern Territory.
- Plets, G., W. Gheyle, G. Verhoeven, J. De Reu, J. Bourgeois, J. Verhegge and B. Stichelbaut (2012) Three-dimensional Recording of Archaeological Remains in the Altai Mountains. *Antiquity* 83(333): 884–97.
- Powel, A. (2013) The Air Raids on Darwin, 19 February 1942: Image and Reality. In P. Dean (ed.) *Australia 1942: In the Shadow of War*, pp. 140–56. Cambridge: Cambridge University Press.
- Rechniewski, E. (2012) Forgetting and Remembering the Darwin Bombings. *Revue électronique d'études sur le monde Anglophone* 10(1). <http://erea.revues.org/?lang=en> (retrieved 18 March 2015).
- Riseman, N. (2012) Rectifying 'the Great Australian Silence': Creative Representations of Australian Indigenous Second World War Service. *Australian Aboriginal Studies* 1(1): 35–48.
- Roberts, J. and M. Young (2008) Transience, Memory and Induced Amnesia: The Re-imagining of Darwin. *Journal of Australian Studies* 32(1): 51–62.
- Shanahan, F. (2014) *World War II Conflict Aviation Archaeology: Managing World War II Aviation Sites in Australia and the Marshall Islands*. Unpublished Master's thesis. Melbourne: La Trobe University.
- Stanley, P. (2005) Threat Made Manifest. *Griffith Review* 9: 12–24.



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World War II Conflict and Post-conflict Landscapes in Northwest France: An Evaluation of the Aerial Photographic Resource

David G. Passmore, David Capps Tunwell and Stephan Harrison

Abstract

This chapter explores the utility of aerial photographs for investigating landscapes of World War II conflict associated with the Normandy Campaign and the bombing of German military sites in northwest France during 1943 and 1944, and also the lesser known history of landscape rehabilitation and remediation in the immediate post-war recovery period. The primary resource used here is vertical aerial photographs at scales between c. 1:1,500 and 1:26,000, taken between 1945 and 1960 and accessible from the online archive hosted by the Institut Géographique National (IGN). Our analysis focuses on rural areas impacted by one or more Allied air raids, either because they witnessed major Allied ground offensives or were the sites of German military installations. Areas of open agricultural land have rarely preserved any visible evidence of bomb damage, but here the photographic record enables analysis of the intensity and character of bombing and the immediate post-war remediation of farmland. Allied air raids also targeted supply depots and V-weapon facilities concealed in regional forests, and here it is demonstrated that forest clearance associated with fires and late- and post-war munitions disposal activities have combined to render formerly camouflaged military sites, bomb craters and remediation landscapes as readily visible on aerial images.

Keywords: aerial photographs, World War II, northwest France, bomb craters, remediation.

Introduction

The maturing of aerial photography as a military reconnaissance and analysis tool during World War II has left a legacy of images that have subsequently been widely deployed in the historical and archaeological analysis of the period's conflict landscapes (for example Stichelbaut et al. 2009, Cowley et al. 2010). To date, aerial images have perhaps been most extensively used in historical accounts and battlefield guides of campaigns in the northwest European theatre of World War II, especially to illustrate the aerial bombing campaigns of British and German cities (for example Overly 2013), V-weapon sites (for example Williams 2013) and the conflict landscapes of the D-Day landings and the subsequent campaigns through France, the Low Countries and eventually Germany (for example Herington 1963, Copp and Bechthold 2011). The use of battlefield and target imagery has also been complemented by increasing interest in the wartime photographic record of a wider range of conflict-related landscapes, for example to assist detection of military grave sites (Abicht 2010) and for analysis of concentration camps (Uziel 2010), prisoner of war (PoW) camps (Doyle et al. 2013), military support infrastructure (for example Newsome 2009, Easton 2009, 2010) and D-Day preparations in the UK (for example Crutchley 2009, Stoertz 2010, Easton 2010).

These examples all draw on the considerable volume of vertical aerial reconnaissance photographs taken for military purposes during the war itself, but more recent studies have also begun to use post-war images to examine aspects of World War II conflict and its immediate post-war legacy. In France, for example, these include studies of post-war PoW camps (Early 2013, Mytum and Carr 2013) and the authors' own work on the archaeology of the German logistics network in northwest France and the efforts of Allied strategic and tactical air forces to bomb the supply depots (Passmore et al. 2013, 2014, Capps Tunwell et al. 2015). These investigations have been greatly facilitated by the aerial photographic archive administered and made public by the Institut Géographique National (IGN): here we return to this archive in order to extend the analysis of conflict and post-conflict landscapes in northwest France, with particular reference to sites associated with the Normandy Campaign and the wider array of German military infrastructure.

Having largely escaped significant war damage during the German conquest of France in summer 1940 (with the notable exception of the towns of the Lower Seine; Clout 1999), large areas of the rural landscape of northwest France were transformed by German preparations for the defence of the continental mainland. Military targets and the wider regional transport infrastructure became the focus of Allied bombing throughout 1943 and 1944 in preparation for, and support of, the D-Day landings and the subsequent battle for Normandy. Extensive additional areas were rendered unusable by ground combat and associated shelling and bombing (in the department of Manche, for example, some 35,000 hectares of land was impacted by the D-Day landings themselves; Clout 2006), while the rapid development of

Allied airfields, camps and supply depots removed at least a further 200,000 ha of farmland in the departments of Manche and Calvados alone (Clout 2006).

In the case studies below we present interpretations of aerial photographs spanning the period 1945–60 with the aims of evaluating (i) the evidence for military installations developed before and during the Normandy Campaign, (ii) the extent and character of Allied bomb damage on agricultural and forested settings (including the battlefields of major Allied breakout operations in the vicinity of Caen and Saint-Lô) and (iii) the process and timescale of post-conflict landscape rehabilitation that in most agricultural landscapes has removed any modern surface evidence of conflict. In capturing the landscape traces of the conflict legacy in post-war Normandy, these images not only illuminate some of the earliest reconstruction activities in what Clout (2008) terms the ‘emergency’ phase in the region, but also draw attention to the rehabilitation of rural and forested environments which, by comparison to the longer-term history of urban renewal following both world wars (for example Clout 1999, Knapp 2007), have received rather less attention from scholars and command little profile in Normandy’s conflict heritage (see also Clout 2006, 2008).

The Institut Géographique National Photographic Archive

The primary resources used in this study are vertical aerial photographs taken and archived by the Institut Géographique National (IGN). Established in 1940 in replacement of the disbanded Service Géographique de L’Armée, from May 1946 the IGN assumed responsibility for a national photograph library (Centre de Documentation de Photographies Aériennes; Plu and Ducher 1988) and has since orchestrated the taking and archiving of aerial photographic records of the country with the intention of systematically renewing the countrywide orthophotographic cover every 3–10 years (depending on the speed of urban and industrial development). By 1953 the IGN had accomplished a complete aerial photographic coverage of the national territory at c. 1:25,000 (much of this flown by ex-USAF B-17 aircraft; IGN 2015), although many areas physically impacted by the war were the focus of additional larger-scale photographic sorties. Since 2012 the aerial photograph collection has been administered by the Institut National de l’Information Géographique et Forestière as a result of the merger between the Institut Géographique National and the Inventaire Forestier National (IFN), although the new body maintains the same IGN acronym.

In contrast to many national or agency collections of aerial photographs that are not well catalogued or difficult to access (Bourgeois and Stichelbaut 2009), a great many of the IGN’s historical aerial images are freely available for viewing and download from the IGN’s online map service ‘Géoportail’ (www.geoportail.gouv.fr). IGN images used in this study date to the period 1945–60 with the majority taken in the four years after the end of World War II.

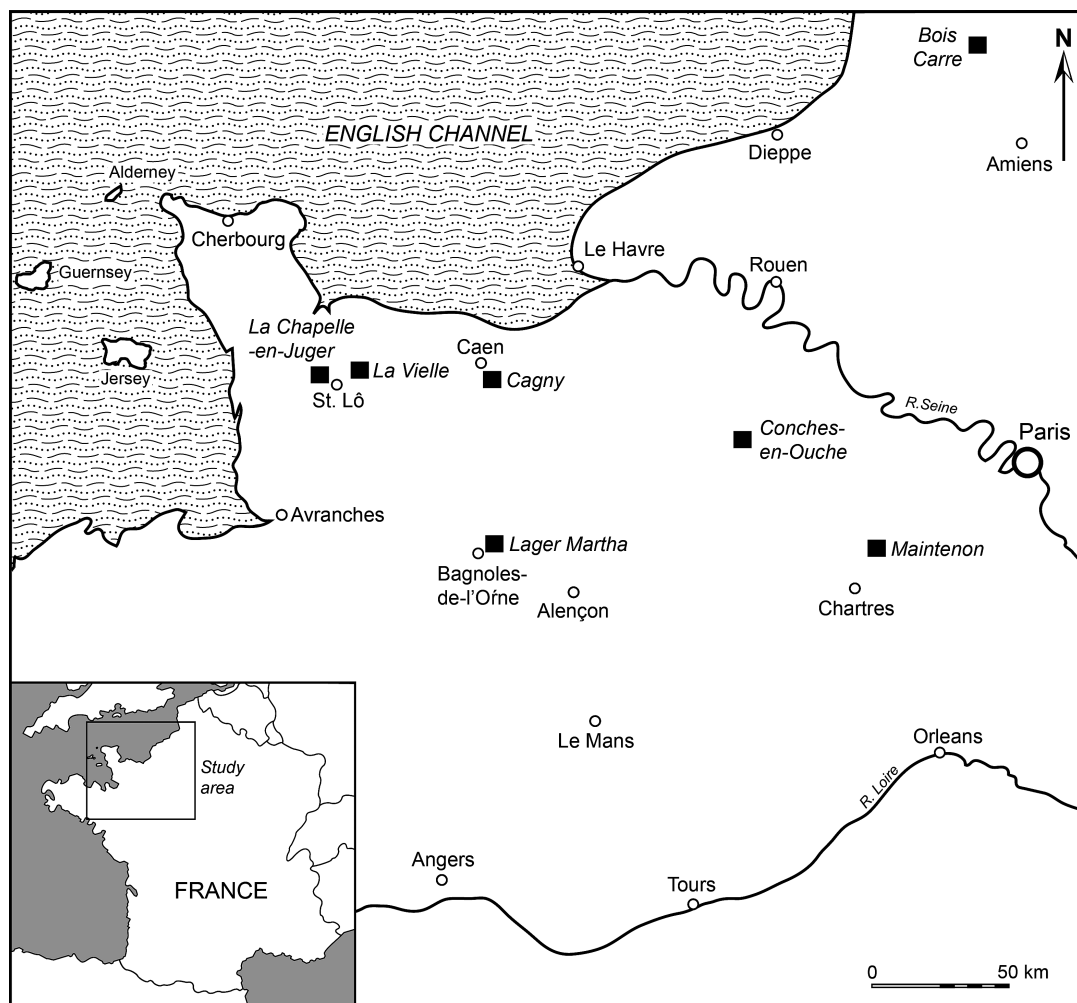
Most are large-scale images in the order of 1:24,000 to 1:26,000 with some at larger scales between 1:4,000 to 1:6,500 offering very high levels of detail. Images have been scaled and rotated for analysis and reproduction using image manipulation and GIS software, while overlapping frames in many sorties have permitted the use of stereoscopic analysis of bomb-damaged features and terrain.

Landscapes of Aerial Bombing

Landscapes of northwest France bear witness to the full range of Allied aerial bombing procedures and technology in late 1943 and 1944, ranging from combat air support (CAS) and armed reconnaissance missions flown by fighter-bombers to dedicated and often repeated attacks by light, medium and heavy bombers on military targets and transport infrastructure behind the front lines. Case studies below include some of the most heavily-bombed areas in the region inland from the D-Day beachheads. We begin with two examples of large-scale attacks by heavy bombers, taking place over minutes or hours in direct support of major Allied ground offensives. Thereafter the focus switches to examples of attacks on fixed military sites and installations, characterised by raids of smaller numbers of aircraft (and usually medium bombers) but repeated on multiple occasions over the course of weeks or months before and during the Normandy Campaign. Examples span readily identified sites such as the Luftwaffe airfield at Conches-en-Ouche, and others that were concealed in forests, including the V-weapons site at Bois Carré and German munitions depots at Maintenon and in the Forêt domaniale des Andaines and adjacent to Conches-en-Ouche airfield. We also consider the site of an Allied temporary airfield at Lavieille, near Saint-Lô, which escaped any significant bombing but which nevertheless had a considerable impact on the immediate landscape.

GROUND OFFENSIVES

Some of the most heavily-bombed rural landscapes in Normandy had no intrinsic military significance until their geographical context aligned with major Allied ground assaults. This was the case in the vicinity of the village of Cagny, 9 kilometres southeast of Caen (Figure 11.1) and one of several potential strongpoints bombed by Allied aircraft ahead of the planned armoured breakout of Operation Goodwood on 18 July 1944. This was also true of the landscape north of La Chapelle-en-Juger, 9 kilometres west of Saint-Lô, that was bombed on 25 July in advance of the Operation Cobra breakout by the US First Army (Figure 11.1). Both sites have been subjected to detailed historical study on account of their importance in the offensive narratives (for example Gooderson 1992, Carafano 2009) but are considered here on account of the photographic record of bomb damage and subsequent recovery.



Cagny

The raid on Cagny took place early in the morning of 18 July 1944 by 106 heavy bombers of the RAF dropping a total of 650 tons of bombs (Gooderson 1992, Moore 2007). Many of the bombs dropped in support of Goodwood were fitted with instantaneous fuses in order to avoid deep cratering of the ground that would hinder armoured operations, and it has been argued that all of the bombs dropped on Cagny were so fitted (Gooderson 1992). The characteristic blast rings of such bombs can indeed be seen on an aerial reconnaissance photograph of Cagny taken shortly after the raid (Figure 11.2A; see Ford and Dennis 2004). The majority of bomb impacts shown in this frame, however, are evidenced by well-defined craters and scatters of debris that are more consistent with the use of delayed fusing and bomb detonation below the ground surface (Figure 11.2A). Furthermore, an IGN aerial photograph of Cagny taken on 12 October 1945 (Figure 11.2B) shows that while there is

11.1 Map of northwest France showing locations of case study sites
© authors

11.2 A) Aerial reconnaissance photograph of Cagny (IWM CL477) taken on the morning of 18 July 1944 following bombing in support of Operation Goodwood; B) Aerial photograph of Cagny taken on 12 October 1945 (IGNF C1612-0091_1945_CDP216_0747) showing cratering associated with bombs fused with a 0.25 second delay. Note lack of evidence for cratering associated with bombs with instantaneous fuses (see text for details). Inset frames show location of [Figures 11.3A](#) and [11.3B](#)

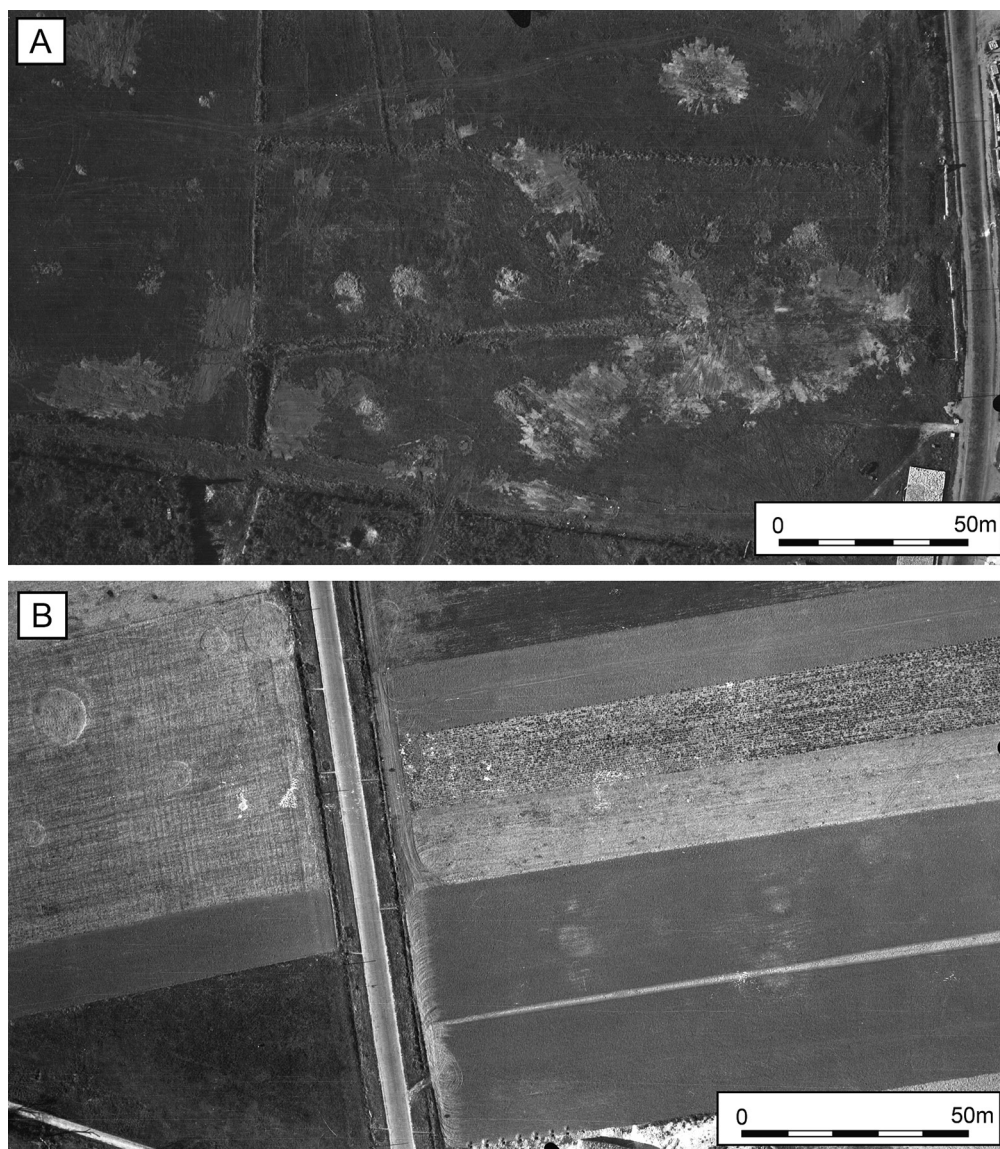


little or no evidence of cratering in the locations impacted by bombs with instantaneous fuses, most of the craters associated with delayed fuses still survive in the landscape around the village except for occasional fields where craters appear to have been already infilled by this date.

A series of exceptionally large-scale images (1:1,500) taken of Cagny exactly one year later in October 1946 illustrate the degree and nature of ongoing field restoration efforts ([Figure 11.3](#)). Irregular patches of bare earth or young grass with track or tyre marks in [Figure 11.3A](#) shows recently-infilled craters in pasture near the village centre, although it is interesting to note that at least two craters survive in the adjacent scrub. Ploughed and cultivated fields on the northwest margin of the village also show evidence of infilled craters although here the process appears to be more advanced with the craters evident as circular cropmarks or slight depressions ([Figure 11.3B](#)). Later post-war IGN images (not shown here) show that by August 1947 examples of extant craters are limited to only occasional examples in scrubland or rough pasture and from 1955 even cropmark evidence is limited.

La Chapelle-en-Juger

On 25 July 1944 the village of La Chapelle-en-Juger lay in the centre of a rectangular target area of c. 17 square kilometres sited over the German frontline west of Saint-Lô ([Figure 11.1](#)) and designated as the focus of the Operation Cobra breakout by the US First Army (Carafano 2009). In addition to strikes by fighter- and medium bombers, 1,495 heavy bombers of the US Eighth Air Force delivered 2,060 tons of high explosive and 2,346 tons of



11.3 Aerial photographs of infilled bomb craters in fields at Cagny taken on 12 October 1946 (see [Figure 11.2](#) for location): A) IGNF C1612-0291_1946_CDP2202_4120; B) IGNF C1612-0291_1946_CDP2202_4124 © authors

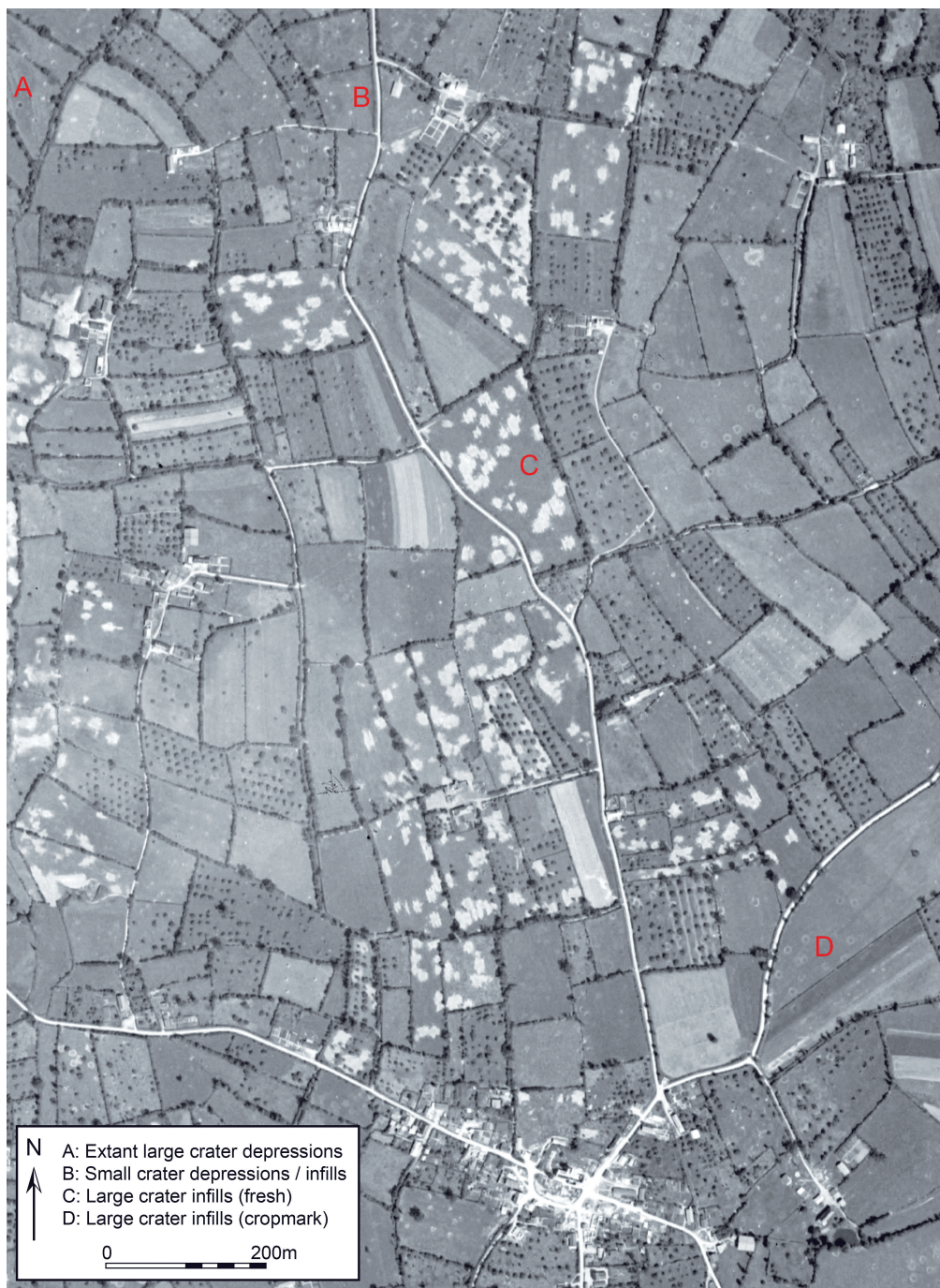
fragmentation bombs in and around the target box and, while not eliminating German opposition, the raid weakened resistance sufficiently such that by 27 July the US forces had broken through and were poised to exploit to the south, thus achieving the long-awaited breakthrough on the Normandy front. [Figure 11.4](#) is an extract from an IGN aerial photograph taken on the 25 July 1947 showing the landscape between La Chapelle-en-Juger north to the D900 between Saint-Lô and Périers which effectively marked the frontline prior to Operation Cobra. This image testifies to the intensity of the Operation Cobra raids with few fields appearing to have escaped bomb impacts, but considerable field-by-field variation in the nature of damage and the degree of restoration to agricultural use is evident. Here we present a fourfold classification of damage/restoration as follows ([Figure 11.4](#)):

- a. Occasional isolated circular depressions, approximately 6–7 metres in diameter with dark interior shading, are evident in some fields and are interpreted as craters that have escaped infilling and persist in the landscape as small ponds or wetlands. Their survival may reflect a functional use for livestock watering or habitat diversity.
- b. Relatively small (c. 3–4 metre) circular or sub-circular lightly-shaded and shallow depressions are interpreted as small disturbances of bare earth or young grass that most likely reflect bomb impacts with little or no cratering. Some of these features may reflect the impact of instantaneously-fused bombs although other possibilities include fragmentation or incendiary bomb types.
- c. Numerous relatively large (c. 10 metre) sub-circular or irregular patches of very light shading, present as both discrete and merged examples but with no surface depression, bear a close resemblance to freshly-infilled craters at Cagny ([Figure 11.3A](#)) and are also interpreted as areas of bare earth or young grass that reflect infilling and levelling of bomb damage.
- d. Relatively large (c. 10 metre) circular crop- or soil marks with no surface relief reflecting infilled and levelled craters are abundant in fields in the central and eastern part of the frame and are most probably amongst the earliest fields to be restored to agricultural use.

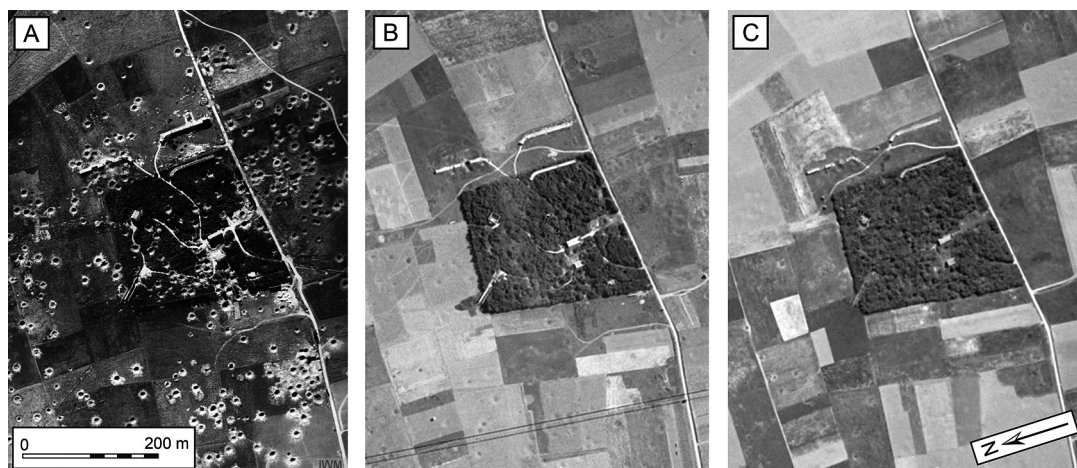
Comparison of the 1947 image with IGN photographs dating from 1955 (not shown here) show evidence of bomb damage a decade after the war to be limited solely to faint cropmarks in some, though by no means all, impacted fields.

BOIS CARRÉ V-WEAPON SITE

Bois Carré, near Yvrench, Picardy ([Figure 11.1](#)) was one of six sites near the French Channel coast photographed on 3 November 1943 and identified as potential V-weapon facilities by a dedicated section of the Allied Central Interpretation Unit (ACIU) based at RAF Medmenham (Le Maner 2009, Williams 2013).



11.4 Aerial photograph dated 25 July 1947 (IGNF C1213-0071_1947_F1213-1313_0023) of La Chapelle-en-Juger (lower frame), near Saint-Lô, showing extant and infilled bomb craters associated with Operation Cobra



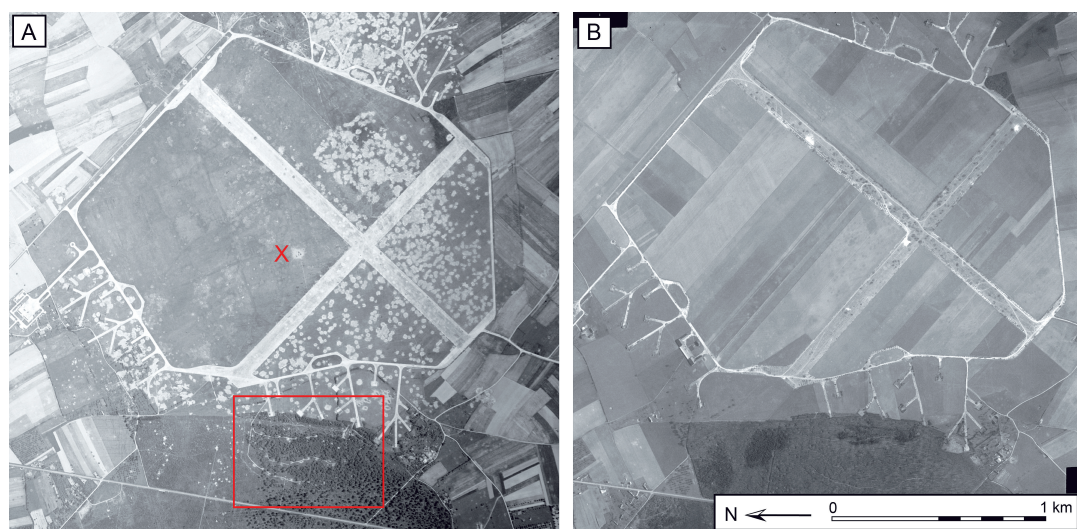
11.5 Aerial photographs of V-weapons facility in Bois Carré, near Yvrench, Picardy: A) Reconnaissance picture dated 28 June 1944 (IWM: HU 92984) showing bomb craters of raids between 31 December 1943 and 19 June 1944; B) IGN image dated 2 October 1947 (IGNF C2207-0031_1947_F2207-2307_0165); C) IGN image dated 29 April 1952 (IGNF C2007-0061_1952_F2007-2307_0062)

Distinctive V1 launch ramps and storage bunkers (the latter nicknamed ‘Ski Sites’ on account of their planforms) in and immediately adjacent to woodland at Bois Carré became the reference objects used subsequently to identify a further 95 V1 sites in northwest France following a photographic sortie on 22 November (Le Maner 2009). All of these sites were subsequently targeted by an Allied bombing campaign codenamed ‘Crossbow’ and Bois Carré was attacked on at least 10 occasions between 31 December 1943 and 19 June 1944 by medium and light bombers of the RAF and US Ninth Air Force (Robertson et al. 2013).

An aerial reconnaissance photograph taken on the 28 June 1944 (Figure 11.5A) clearly demonstrates the extent and accuracy of the bombing effort; numerous bomb craters within the facility, including several direct hits on structures, attest to the success of the raids which ultimately forced the abandonment of the site before any successful launch of V1 missiles (Le Maner 2009). The aerial reconnaissance images also show, however, that the majority of bombs fell on the patchwork of open field systems surrounding Bois Carré with few individual fields escaping at least some degree of bomb damage (Figure 11.5A). Post-war IGN images show that the configuration of field systems remains largely unchanged over the next eight years with the majority of craters having been infilled by October 1947, although many examples appearing to remain extant to the north and east of the wood (Figure 11.5B). By April 1952 rehabilitation is sufficiently advanced such that the visible traces of craters appear to be largely limited to cropmarks (Figure 11.5C) and, while many of the installation structures and associated bomb craters in the woodland area have survived to the present day, the modern agricultural landscape surrounding the site shows no extant evidence of the raids.

AIRFIELD SITES

Newly-constructed or expanded military airfields were a conspicuous feature of Normandy’s rural landscape during World War II but presented very different scenarios for their landscape legacy depending on whether they



were occupied by German or Allied air forces. Many German airfields, being developed and expanded over the years since the occupation of Normandy in 1940, were provided with extensive hardened runways and support facilities and were amongst the most heavily bombed landscapes of the Normandy region.

Developed from a former French airfield between 1941 and 1943, the airfield at Conches-en-Ouche was located 3 kilometres south of the town with two hardened runways and numerous dispersal hardstands located off a perimeter taxiway (Figures 11.1 and 11.6; deZeng IV 2014). During the Normandy campaign the airfield hosted Luftwaffe fighters and fighter bombers and was the target of at least 14 raids by heavy and medium bombers of the USAF between August 1943 and July 1944 (Robertson et al. 2013). Following abandonment of the airfield after the German retreat from Normandy the facility returned to agricultural use and by 1 July 1947 much of the northern area retained evidence for bombing as cropmarks only, while cratering in other parts of the airfield is in the process of being infilled and levelled (Figure 11.6A). Runways and other hardened facilities, by contrast, are likely to have been deemed too expensive to remove and with little incentive to repair they remain extensively cratered. A distinctive cluster of craters and disturbed ground near the centre of the airfield (Figure 11.6A) is interpreted as evidence of ordnance disposal by controlled detonation (see also below). By March 1960 the runways still exhibited extant bomb craters but the field areas retain only faint cropmark evidence of the wartime bombing legacy (Figure 11.6B).

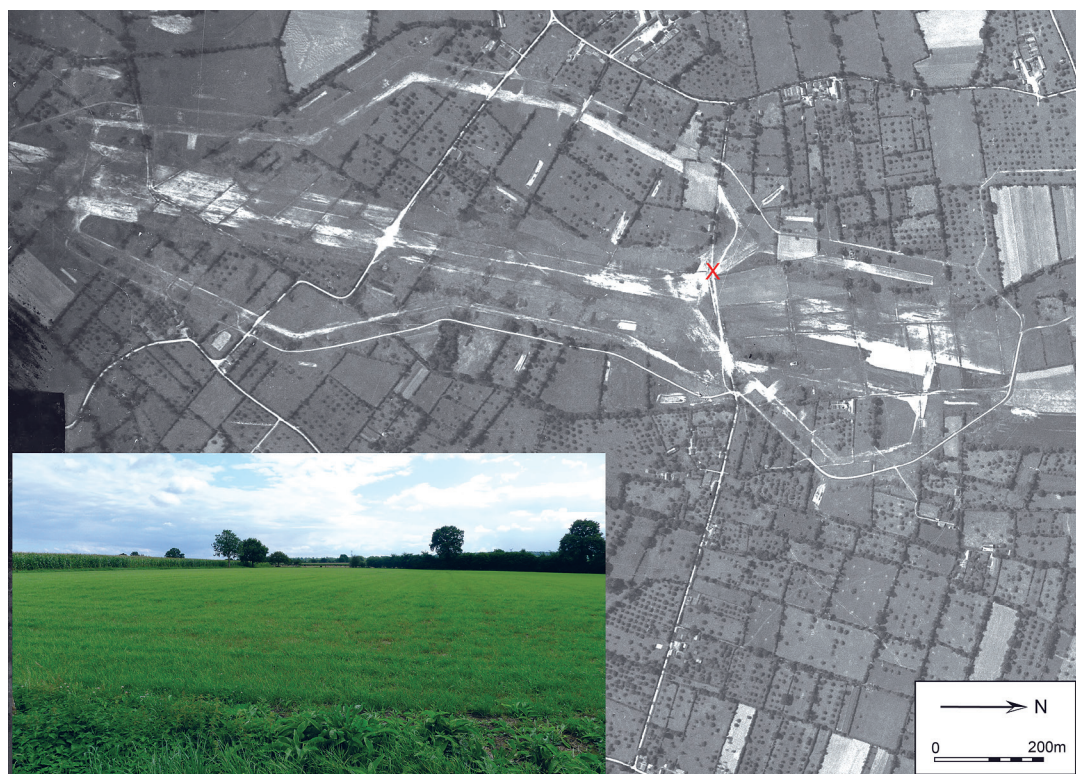
The rehabilitation of permanent airfield sites in Normandy to an operational capacity was greatly accelerated if Allied air forces adopted these fields for their own use but, and especially early in the campaign, Allied aircraft based in Normandy were typically operating from temporary Advanced Landing Grounds (ALG) that were rapidly developed in convenient agricultural areas

11.6 Aerial photographs of ex-Luftwaffe airfield at Conches-en-Ouche, Haute-Normandie: A) IGN image dated 1 July 1947 (IGNF C1914-0011_1947_F1914-2115_0054); B) IGN image dated 7 March 1960 (IGNF C1914-0041_1960_F1914-2214_0011). Inset frame shows location of airfield ammunition depot (Figure 11.10). Locality X (11.6A) marks ordnance disposal activities

by engineer units. In contrast to German airfields these facilities generally escaped intense bombing owing to the relative weakness of the Luftwaffe at this time, but the construction of runway and hardstand facilities nevertheless had a marked impact on local rural landscapes both during and after the conflict. An example of this impact is captured by IGN images dating to August 1947 at Lavieille, near St-Georges-d'Elle, 9 kilometres northeast of Saint-Lô (Figures 11.1 and 11.7). These reveal the site of ALG A-19, constructed between 31 July and 13 August 1944 by the 818th Engineer Aviation Battalion, IX Engineer Command (United States Air Force 1945) and typical of many such facilities constructed to a standard template throughout this part of Normandy at the time. The airfield facilities have been recorded as comprising a 1,524 metre $\times$ 36.5 metre runway of bitumen/hessian mat (including a 427 metre compacted earth extension) encircled by a 3-mile taxiway with 75 hardstands and a network of access roads and storage facilities (United States Air Force 1945). The airfield was operational from 14 August until its closure on 7 September 1944, during which period it hosted P-38 Lightning fighter-bombers of the 370th Fighter Group. By September 1947 the imagery clearly shows the airfield facilities and surfacing have been removed and the site is in the process of being returned to agricultural use, including the restoration of former field boundaries and minor roads (Figure 11.7). Nevertheless, the detailed plan of the runway and many elements of the encircling facilities are clearly evident as disturbed or bare earth surfaces within the surrounding pasture. Several small fields within the perimeter taxiway, however, show little or no evidence of disturbance and these retained their field boundaries and orchards during the period of airfield construction and operational use. The rehabilitated field systems and road network at this site exhibit no modern surface evidence of their previous military history and serve to emphasise the value of the aerial photographic resource as a landscape analysis tool.

MUNITIONS STORAGE AND DISPOSAL LANDSCAPES

The utility of aerial photographs as a study aid in forested settings may seem surprising given that German logistics facilities typically used densely forested woodland sites in order to conceal them from aerial observation (Passmore et al. 2013, 2014, Capps Tunwell et al. 2015). However, forest clearance associated with fire (especially that associated with air raids), demolition efforts by retreating German forces and late- and post-war munitions disposal activities have on occasion combined to render many military and bombing landscapes readily visible on aerial images. A striking example may be found at Maintenon (Eure-et-Loire department) where a major Luftwaffe munitions storage facility (Middlebrook and Everitt 2014) developed in woodlands on the margins of the town is extensively visible on 1949 aerial images. Two further examples of munitions facilities described below benefit from the availability of relatively large-scale aerial images (c. 1:4,500–1:6,500) which capture high-resolution details of munitions facilities and disposal activities in woodland locations. These are respectively

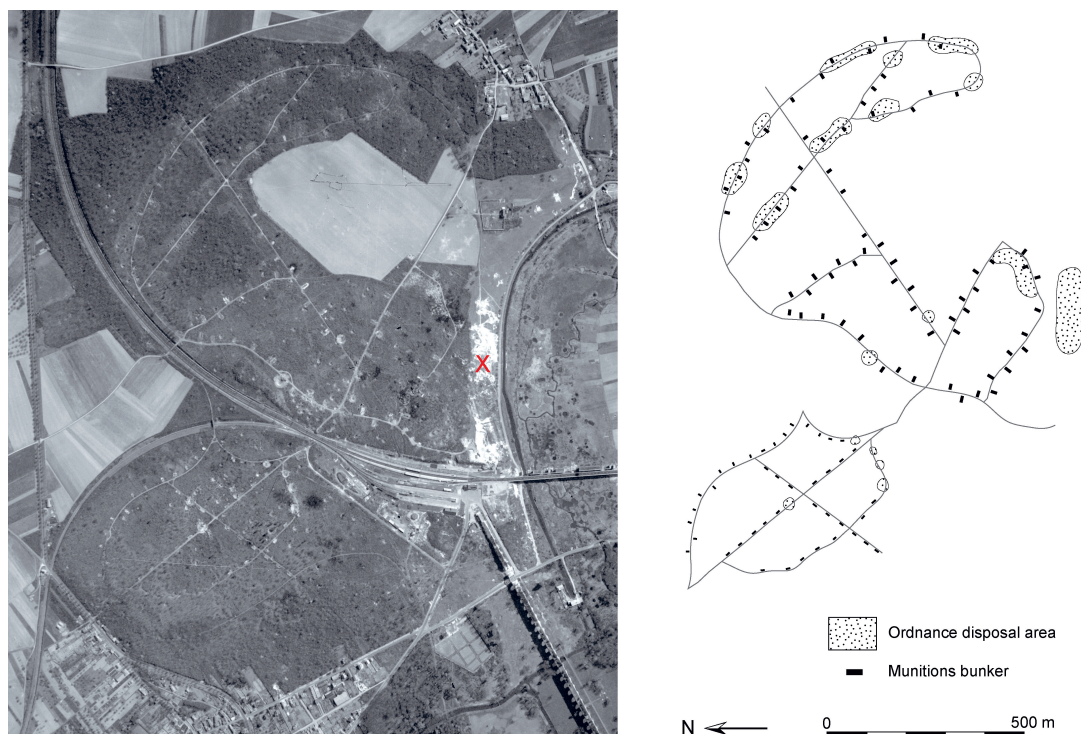


the Seventh Army munitions depot codenamed Lager Martha, located in the Forêt domaniale des Andaines, near Bagnoles de l'Orne, and the munitions (bomb) dump attached to the Luftwaffe airfield at Conches-en-Ouche (Figure 11.1).

Maintenon

The primary Luftwaffe munitions facility at Maintenon comprised two adjacent and linked sites to the east and west, respectively, of the Maintenon railway station and marshalling yard (a third and smaller facility on the southwest edge of the town is not shown here). Figure 11.8 presents an interpretation of the depot road network and individual munitions bunkers where they can be identified on the aerial image of 14 April 1949, accepting that the map is most likely an underestimate of the number of bunkers prior to bomb damage and disposal activity. The western site is smaller (c. 2 square kilometres) with bunkers some 8–12 metres in length orientated both perpendicular and parallel to the road network. To the east the larger of the sites extends over about 5 square kilometres and features over 75 bunkers that appear to be larger than those to the east (up to c. 16 metres in length) and lying perpendicular to the depot roadways. At this stage it is not known how bunker size and configuration relates to differing ordnance types.

11.7 Aerial photograph dated 9 August 1947 (IGNF C1411-0051_1947_F1411-1612_0057) showing site of former Allied Advanced Landing Ground A-19 at Lavieille (St-Georges-d'Elle), near Saint-Lô. Inset: Photograph of the present site of airfield, taken from location X looking south along the former runway



11.8 Aerial photograph dated 14 April 1949 (IGNF C1816-0011_1949_F1816-2116_0014) and interpretation of Luftwaffe ammunition depots at Maintenon. Locality X marks off-site ordnance disposal area

The Maintenon depots were targeted on at least two occasions by both RAF and USAF bombers in April and August 1944, respectively, and nearby bridges and oil facilities were also attacked (Robertson et al. 2013). Numerous bomb craters are still evident in the depot areas even some five years after war, notably in those areas flanking the railway lines and station, and are particularly well-preserved in the floodplain of the La Voise river immediately to the south of the sites (Figure 11.8). Within the depot area itself, however, a good proportion of ground disturbance is likely to reflect activity in the late- and post-war period. In particular, conspicuous in the area of some bunkers, especially in the easternmost part of the eastern depot, are dense clusters of very small craters that are interpreted here as ordnance disposal by controlled detonation rather than bombing (Figure 11.8). Several very large craters and associated disturbed ground on depot roads near the railway station appear to correspond with the pattern of bunker locations and, while explosions associated with direct bomb strikes cannot be discounted, these features are also deemed likely to reflect deliberate disposal detonations. Finally, a large area of disturbed ground or bare earth with numerous craters can clearly be seen in the open area between the La Voise and the southern margin of the depot woodlands (Figure 11.8). Accordingly, the overall impression is one of intensive ordnance disposal activity continuing for many years after the cessation of hostilities and rendering large areas of former woodland and adjacent open ground as unusable for forestry, agricultural or recreational activity.

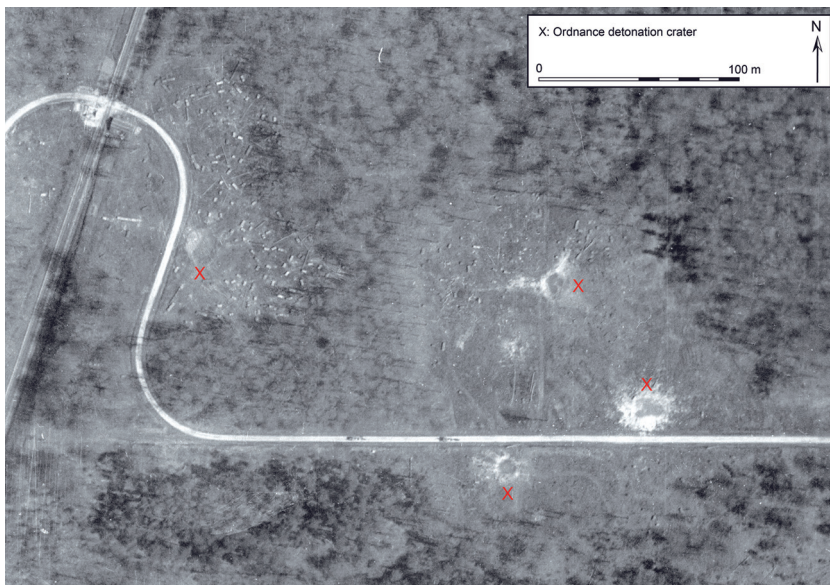
Forêt domaniale des Andaines / Conches-en-Ouche

Lager Martha, located in the Forêt domaniale des Andaines to the north and east of Bagnoles de l'Orne (Figure 11.1) was one of the largest German Seventh Army munitions depots in Normandy at the time of the D-Day landings. This facility escaped bombing raids before and during the campaign and continued to function until it was overrun by American troops on 14 August 1944 (Capps Tunwell et al. 2015). Munitions bunkers are especially well-preserved in the forest and the combination of archaeological survey and IGN aerial photograph analysis has permitted the geography of the depot to be mapped in detail (Capps Tunwell et al. 2015). Although retreating German forces were recorded as detonating munitions before abandoning the depot, significant amounts of live ammunition were reported as remaining on-site by forestry workers (Capps Tunwell, unpublished data) and occasional live shells continue to emerge during modern forestry operations. Large-scale aerial images taken by the IGN in April 1946 (Figure 11.9) reveal patches of cleared woodland in parts of the depot area with a series of large, discrete craters; since the depot was neither bombed nor shelled during its occupation these craters are interpreted as the sites of controlled ordnance detonation, although it is unclear whether some or all of the craters were caused by retreating German troops or post-war disposal teams. The location of the craters closely matches the configuration of munitions bunkers that survive as earthworks in many parts of the depot and hence it is likely that these reflect *in-situ* detonation of individual bunkers.

A similar pattern of ordnance disposal activity can also be seen on IGN images of 14 April 1948 at the site of the airfield ammunition (bomb) dump at Conches-en-Ouche (see above; Figures 11.1, 11.6A and 11.10). Storage facilities here were in hardened (concrete) bunkers located within woodland adjacent to the airfield's western perimeter, but by 1948 these bunkers had been demolished and some, as indicated by large crater depressions on either side of the access road in the northwest part of the depot, appear to have been used to detonate live ordnance. Evidence of explosive demolition of munitions bunkers mirrors practice at Lager Martha (Figure 11.9) and Maintenon (Figure 11.8).

Discussion

With a first complete post-war photographic cover of France achieved in the years up to 1953, and in combination with localised, very large-scale images taken during the same period, IGN aerial photographs constitute an unusually detailed and accessible resource that permits investigation of lesser-known aspects of World War II conflict landscapes. The case studies presented here highlight two areas of ongoing research promise. Firstly, while the ability of aerial photographs to record military structures such as fortifications and (as demonstrated at Conches-en-Ouche) airfields is well established, their



11.9 Aerial photograph dated 23 April 1946 (IGNF C1516-0081_1946_CDP2017_0186) of the Route Forestière de l'Épinette (D387), Forêt domaniale des Andaines, near Bagnoles de l'Orne showing ordnance disposal activities. Detonation craters most probably correspond to sites of former munitions bunkers (see text for details)



11.10 Aerial photograph dated 12 April 1948 (IGNF C1914-0061_1948_CDP3013_0035) of ammunition (bomb) depot on western margin of Luftwaffe airfield at Conches-en-Ouche, Haute-Normandie (see [Figure 11.6](#) for context). Note focus of clearance and disposal activity in southern part of the depot

potential to reveal details of military earthworks and cratering associated with bomb damage and ordnance disposal in forested settings is only just beginning to be explored (Passmore et al. 2014). While some of these landscapes remain well-preserved in present-day forests and may be subject to archaeological survey, others have been degraded or lost completely to urbanisation and mechanised forestry operations (as is the case for parts of the Maintenon munitions facility) and here the aerial photographic archive may constitute the sole means of accessing these landscapes.

It is perhaps ironic that the potential for aerial photographic analysis of logistics facilities in this context is contingent on woodland clearance which, at least in part, reflects fire and blast damage associated with bomb strikes intended to destroy them. A key additional factor, however, appears to be extended or sustained clearance to facilitate landscape remediation and late- and post-war ordnance disposal. This would certainly seem to be the case at Maintenon where – exceptionally – the aerial images permit a near-complete mapping of the depot roads and bunker network (Figure 11.8). Abandoned munitions depots will have demanded considerable clean-up operations in their own right (as attested by post-war forestry records from parts of the *Forêt domaniale des Andaines*; Capps Tunwell, unpublished data), but the utility of these sites as storage and disposal centres for unexploded bombs and shells collected from the surrounding areas is also likely to have rendered them as active disposal sites for some time after the war. Indeed, Clout's (2006) observation that in May 1948 some 2,000 tonnes of recovered munitions were being stored in 10 depots in Calvados alone gives some idea of the scale of the activity. Case studies developed here would appear to confirm ongoing disposal activity in April 1946 in the *Forêt domaniale des Andaines*, April 1948 at the former bomb dump at Conches-en-Ouche airfield and as late as April 1949 at Maintenon.

Forest-based ordnance disposal activities constitute part of a wider research agenda that will benefit from IGN aerial images – that of the reconstruction of war-damaged landscapes in northwest France, and especially those in rural areas. Much of the restoration of farmland was accomplished as a matter of priority after the cessation of hostilities with a particular impetus being provided by the need to clear minefields, unexploded ordnance and combat-related debris as well as restore food production. Clout's (2006, 2008) analysis of Lower Normandy indicates that while the reconstruction of many farmsteads was still in progress well into the 1950s, the filling of bomb craters in the region was largely undertaken during 1945–46. The case studies presented here would appear to broadly support this timescale for farmland although at La Chapelle-en-Juger, Bois Carré and Conches-en-Ouche the crater filling process appears to remain ongoing into 1947. Many of these areas exhibit field systems with differing timescales of crater infilling, perhaps as a reflection of local landownership, land-use requirements and other factors, that demonstrate the process of reconstruction was by no means uniform. Furthermore, bomb craters were to persist for longer periods in some

floodplain localities (for example Maintenon, [Figure 11.8](#)) and other marginal agricultural landscapes, and especially in forests and woodlands where many survive to the present day (Passmore et al. 2014).

The two years after the war also saw work begin to return land requisitioned for Allied camps, supply bases and airfields back to their owners, often with improvements and adjustments to roads and field boundaries (Clout 2008). This process was generally completed by about 1950 (Clout 2008) and photographic evidence at Lavieille shows that restoration of ALG-19 was well advanced by the summer of 1947, but not so far as to remove the detailed impression of the runway and associated facilities ([Figure 11.7](#)). Here, as in the case of bomb-damaged agricultural landscapes beyond the regional forests, modern land surfaces bear little visible evidence of their wartime legacy. Accordingly, it falls to the documentary archive, and especially aerial photographs, to enable an assessment of the extent and character not only of the World War II conflict landscape itself, but also the landscape of rehabilitation.

Conclusions

In the fortifications, battlefields and cemeteries of the D-Day beachhead, northwest France hosts one of the most famous, conspicuous and enduring conflict landscapes of World War II. Yet by far the greater part of its wartime legacy lies inland where, with the notable exception of installations like V-weapon sites and forest-based logistics networks, there are few visible traces of conflict in the modern landscape. The case studies presented here demonstrate that the IGN's unusually comprehensive, accessible and at times very high resolution post-war aerial photograph archive has the potential to illuminate conflict landscapes that are contemporary with the war itself, and which in some cases would be difficult – if not impossible – to analyse by any other means. Simultaneously, and perhaps of equal significance here, they extend our perspective of conflict landscapes beyond the cessation of hostilities and into the period of rural reconstruction and rehabilitation. In doing so they may contribute to an aspect of the physical legacy of World War II that has received relatively little attention in the conflict landscape literature.

References

- Abicht, M.J. (2010) Using Wartime Aerial Photographs to Locate Lost Grave Sites. In D.C. Cowley, R.A. Strandring and M.J. Abicht (eds) *Landscapes Through the Lens: Aerial Photographs and Historic Environment*. Occasional Publication of the Aerial Archaeology Research Group No. 2., pp. 263–6. Oxford: Oxbow Books.
- Bourgeois, J. and B. Stichelbaut (2009) Images of Conflict: An Introduction. In B. Stichelbaut, J. Bourgeois, N.J. Saunders and P. Chielens (eds) *Images of Conflict: Military Aerial Photography and Archaeology*, pp. 1–12. Newcastle: Cambridge Scholars Publishing.

- Capps Tunwell, D., D.G. Passmore and S. Harrison (2015) Landscape Archaeology of World War Two German Logistics Depots in the Forêt Domaniale des Andaines, Normandy, France. *Journal of Historical Archaeology* 19(2): 233–61.
- Carafano, J.J. (2009) *After D-Day: Operation Cobra and the Normandy Breakout*. Mechanicsburg, PA: Stackpole Books.
- Clout, H. (1999) The Reconstruction of Upper Normandy: A Tale of Two Cities. *Planning Perspectives* 14: 183–207.
- (2006) Beyond the Landings: The Reconstruction of Lower Normandy after June 1944. *Journal of Historical Geography* 32: 127–48.
- (2008) Reconstruction in the Manche département after the Normandy Landings. *Modern & Contemporary France* 16(1): 3–21.
- Copp, T. and M. Bechthold (2011) *The Canadian Battlefields in Belgium, the Netherlands and Germany: A Visitor's Guide*. Waterloo, ON: Laurier Centre for Military Strategic and Disarmament Studies.
- Cowley, D.C., R.A. Standring and M.J. Abicht (eds) (2010) *Landscapes Through the Lens: Aerial Photographs and Historic Environment*. Occasional Publication of the Aerial Archaeology Research Group No. 2. Oxford: Oxbow Books.
- Crutchley, S. (2009) Ancient and Modern: Combining Different Remote Sensing Techniques to Interpret Historic Landscapes. *Journal of Cultural Heritage* 10: 65–71.
- deZeng IV, H.L. (2014) *Luftwaffe Airfields 1935–45: France (with Corsica and Channel Islands)*. <http://www.ww2.dk/lwairfields.html> (retrieved 3 July 2014).
- Doyle, P., J. Pringle and L.E. Babits (2013) Stalag Luft III: The Archaeology of an Escaper's Camp. In H. Mytum and G. Carr (eds) *Prisoners of War: Archaeology, Memory, and Heritage of 19th- and 20th-Century Mass Internment*, pp. 129–44. London: Springer.
- Early, R. (2013) Excavating the World War II Prisoner of War Camp at La Glacerie, Cherbourg, Normandy. In H. Mytum and G. Carr (eds) *Prisoners of War: Archaeology, Memory, and Heritage of 19th- and 20th-Century Mass Internment*, pp. 95–116. London: Springer.
- Easton, D.R. (2009) The Scottish Home Front 1939–45: Gathering Information on Military and Civilian Structures from RAF and Luftwaffe Aerial Coverage of Scotland. In B. Stichelbaut, J. Bourgeois, N.J. Saunders and P. Chielens (eds) *Images of Conflict: Military Aerial Photography and Archaeology*, pp. 259–80. Newcastle: Cambridge Scholars Publishing.
- (2010) World War II Aerial Photographs for Military Archaeology in Scotland. In D.C. Cowley, R.A. Standring and M.J. Abicht (eds) *Landscapes Through the Lens: Aerial Photographs and Historic Environment*. Occasional Publication of the Aerial Archaeology Research Group No. 2., pp. 253–62. Oxford: Oxbow Books.
- Ford, K. and P. Dennis (2004) *Caen 1944: Montgomery's Breakout Attempt*. Oxford: Osprey.
- Gooderson, I. (1992) Heavy and Medium Bombers: How Successful Were They in the Tactical Close Air Support Role During World War II? *Journal of Strategic Studies* 15(3): 367–99.
- Herington, J. (1963) *Australia in the War of 1939–1945*. Series Three (Air), Volume IV: *Air Power over Europe, 1944–1945*. Canberra: Australia War Memorial.

- IGN (2015) *L'Histoire de L'IGN*. <http://www.ign.fr/institut/dossiers/lhistoire-de-lign> (retrieved 10 February 2015).
- Knapp, A. (2007) The Destruction and Liberation of Le Havre in Modern Memory. *War in History* 14(4): 476–98.
- Le Maner, Y. (2009) Strategic Aerial Research During the Second World War: The Case of Germany's New Weapons. In B. Stichelbaut, J. Bourgeois, N.J. Saunders and P. Chielens (eds) *Images of Conflict: Military Aerial Photography and Archaeology*, pp. 69–86. Newcastle: Cambridge Scholars Publishing.
- Middlebrook, M and C. Everitt (2014) *The Bomber Command War Diaries: An Operational Reference Book 1939–1945*. Barnsley: Pen and Sword.
- Moore, P. (2007) *Operation Goodwood, July 1944: A Corridor of Death*. Solihull: Helion & Co.
- Mytum, H. and G. Carr (eds) (2013) *Prisoners of War: Archaeology, Memory, and Heritage of 19th- and 20th-Century Mass Internment*. London: Springer.
- Newsome, S. (2009) Suffolk's Defended Shore and Beyond: The Use of Military Aerial Photographs in Systematic Archaeological Survey in England. In B. Stichelbaut, J. Bourgeois, N.J. Saunders and P. Chielens (eds) *Images of Conflict: Military Aerial Photography and Archaeology*, pp. 241–58. Newcastle: Cambridge Scholars Publishing.
- Overy, R. (2013) *The Bombing War: Europe, 1939–1945*. London: Penguin.
- Passmore, D.G., D. Capps Tunwell and S. Harrison (2013) Landscapes of Logistics: The Archaeology and Geography of WW2 German Military Supply Depots in Central Normandy, NW France. *Journal of Conflict Archaeology* 8(3): 165–92.
- Passmore, D.G., S. Harrison and D. Capps Tunwell (2014) Second World War Conflict Archaeology in the Forests of North-west Europe. *Antiquity* 88(342): 1275–90.
- Plu, D. and G. Ducher (1988) Availability of Aerial Photography and Space Images: The Photothèque at the IGN (F), France. *Photogrammetria (PRS)* 43: 83–100.
- Robertson, J.A., R. Burr and B. Barth (2013) *USAF Theatre History of Operations Reports (THOR) Database*. www.afri.au.af.mil/thor (retrieved 30 December 2014).
- Stichelbaut, B., J. Bourgeois, N.J. Saunders and P. Chielens (eds) (2009) *Images of Conflict: Military Aerial Photography and Archaeology*. Newcastle: Cambridge Scholars Publishing.
- Stoertz, C. (2010) US7GR LOC 349 3041 – One Saturday Afternoon on the Home Front. In D.C. Cowley, R.A. Standring and M.J. Abicht (eds) *Landscapes Through the Lens: Aerial Photographs and Historic Environment*. Occasional Publication of the Aerial Archaeology Research Group No. 2., pp. 247–52. Oxford: Oxbow Books.
- United States Air Force (IX Air Force, IX Engineer Command) (1945) *The History of IX Engineer Command: From Its Beginning to V-E Day*. Wiesbaden: Information Control Command Printing Plant.
- Uziel, D. (2010) The Holocaust from Above: Auschwitz Imagery and Beyond. In D.C. Cowley, R.A. Standring and M.J. Abicht (eds) *Landscapes Through the Lens: Aerial Photographs and Historic Environment*. Occasional Publication of the Aerial Archaeology Research Group No. 2., pp. 267–80. Oxford: Oxbow Books.
- Williams, A. (2013) *Operation Crossbow: The Untold Story of Photographic Intelligence and the Search for Hitler's V Weapons*. London: Preface.

Mapping Unexploded Ordnance in Italy: The Role of World War II Aerial Photographs

Elizabeth Jane Shepherd

Abstract

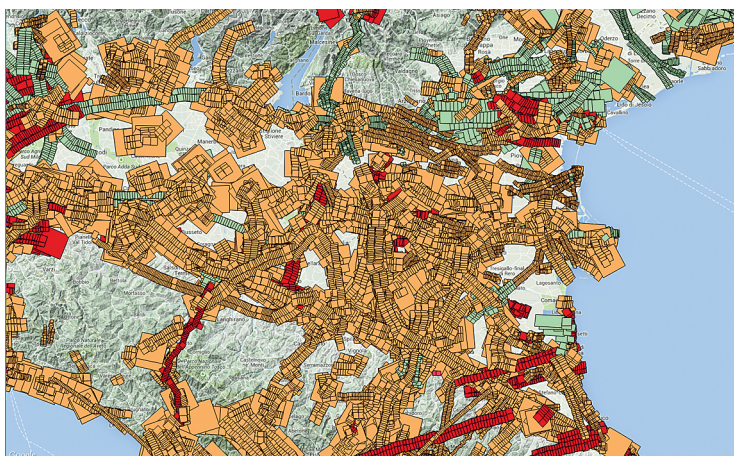
The Aerofototeca Nazionale (AFN) in Rome holds 883,005 aerial photographs of Italy dating to 1943–45, many of them showing the traces left by aerial bombing. The often massive scale of the bombing has left a lasting legacy across the landscape in the problems of dealing with unexploded ordnance (UXO), which continues to be felt on a nearly daily basis. While the AFN collection is a powerful record of the landscapes of wartime Italy, its great potential for the plotting of UXO hazard maps remains under-developed. This paper outlines the scale of the UXO problem, and the current provisions of the law and practice, illustrating the continuing lethal legacy of World War II in present-day Italy.

Keywords: World War II, unexploded ordnance, Italy, lethal legacy.

Introduction

During World War II aerial photographic reconnaissance played a decisive role in the success of the Allied strategic bombing campaigns. Repeated aerial reconnaissance provided information to identify targets, plan attacks and assess damage inflicted by bombing, creating large numbers of photographs, many of which are preserved in archives. These include 883,005 wartime images held by the Aerofototeca Nazionale (AFN), an archive of the Central Institute for Catalogue and Documentation (ICCD) in the Ministry of Cultural Heritage. This collection originates in the work of the Mediterranean Allied Photo Reconnaissance Wing (MAPRW), produced by reconnaissance activities in the 1943–45 Italian Campaign. It comprises 600,000 United States Army Air Force (USAAF) images donated by the American Academy in Rome to the

12.1 Cover plot of selected MAPRW imagery held by AFN for Emilia Romagna. Red outlines show coverage from 1943, orange from 1944 and green selected coverage from 1945. By permission of the Istituto Centrale per il Catalogo e la Documentazione – MiBACT



Italian State in 1964, and 283,005 Royal Air Force (RAF) photographs deposited with the AFN by the British School at Rome in 1975. The historical significance, the image quality and the completeness of the associated information make this the most important collection of World War II aerial photographs in Italy (Shepherd et al. 2012). Recent research (Ceraudo and Shepherd 2010) has also revealed that at least some of the AFN images are not duplicated in other archives (for example in The Aerial Reconnaissance Archive TARA/NCAP and the National Archives and Records Administration NARA; see Cowley et al. 2010, 2013, Cowley and Stichelbaut 2012, Hanson and Oltean 2013). A complete survey of AFN's MAPRW collection, with the identification of duplicate photos, is now in progress (Figure 12.1).

Two contrasting impressions emerge forcefully when scrolling through these photographs. On the one hand there is the record of the almost idyllic condition of the Italian landscape, and on the other the dramatic traces of heavy, repeated bombing. The aerial photographs are a powerful documentation of the wartime landscape and a resource to explore the past conflict landscapes for writing history and for the archaeology of conflict, as explored in other chapters in this volume. Moreover, in the context of this chapter the aerial perspective is presented not only for its heritage information, but also as sources of information to deal with the unwelcome and lethal legacy of wartime bombing, that today still claims lives as the contemporary landscape is reworked and developed.

The Scale of Bombing

Italy was first attacked the day after entering the war against Britain and France, with air raids on Genoa and Turin on 11 and 12 June 1940. The last bombing took place on 4 May 1945. While there is plenty of information available about the air missions over Italy (Baldoli 2010, Bombing Italy 2015, Gioannini and Massobrio 2007, Labanca 2012), the total number of casualties from bombing

is unknown. Official sources (Gioannini and Massobrio 2007: 491–2, Bombing Italy 2015) report 70,591 deaths, but this is probably an underestimate. To take the case of Turin, over the five years between June 1940 and April 1945 the city was subjected to 40 air strikes, with an estimate of 2,139 deaths (Museo Torino 2015) although casualties were certainly far higher. Counting the number of bombs dropped on the country is even harder, though official Allied statistics (Bombing Survey 1947) state that 378,891 tons of ordnance were dropped, amounting to 13.7 per cent of the total dropped on Europe (Figure 12.2). According to some recent estimates this could correspond to about one million bombs (Gironi 2011: 159, Furlanello et al. 2004).

The problem is magnified when trying to calculate the number of unexploded aerial bombs (that is unexploded ordnance or UXO, which refers to munitions that were armed and fired, but did not explode through malfunction for a variety of reasons). According to the US Department of Defense (2003) the percentage of malfunctioning fuses in these bombs is between 8 and 10 per cent. For Italy, this would correspond to 37,900 tons of bombs or roughly 80,000 to 100,000 munitions of various types still potentially present in the ground. These ranged from 4 lbs incendiary bombs to large demolition bombs, such as the HC 4,000 lbs ‘cookie’, and included explosive, incendiary, fragmentation and chemical agents (see Gironi 2011 for illustrations). Unexploded air bombs are the most dangerous, but these are also less frequently encountered than artillery shells, rockets, grenades, hand grenades and small arms ammunition. The latter are remnants of combat actions or may have been concealed by retreating armies or partisans, and are often found in large amounts and are no less lethal than the heavy bombs. This legacy of World War II continues to cause casualties in Italy today and is documented by the Associazione Nazionale Vittime Civili di Guerra (ANVCG – National Association of Civilian Victims of War).

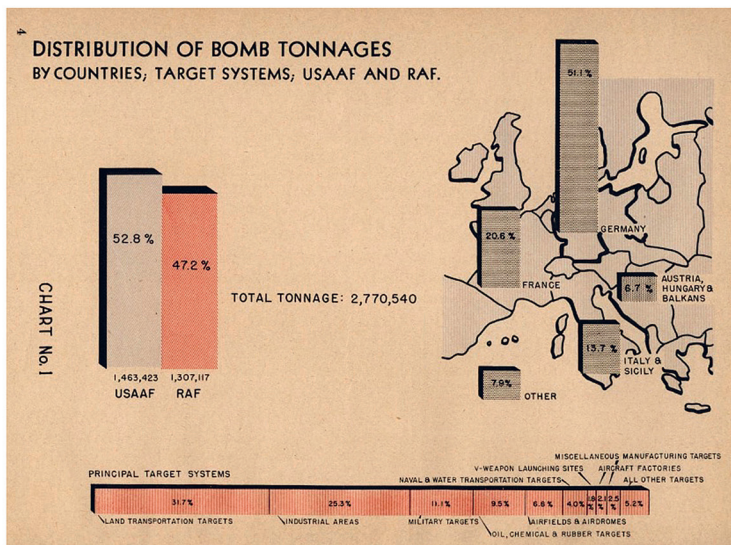
The Problem of UXO in Post-war Italy

Already during the war attention was being given to the problem of UXO. In 1945 the Sezioni di rastrellamento bombe e proiettili (‘Bomb and Shell Recovery Sections’), established in the Military Territorial commands, were in charge of the first emergency operations. From 1946 survey was entrusted to civilian companies and was officially declared complete on 31 October 1948, although later evidence showed that this was not the case. Given the uncertainty over the total number of unexploded bombs in Italy by 1945, it is hard to assess with any accuracy the number or percentage of unexploded aerial bombs still present in Italy. In fact, available figures show great variability, and since much of the UXO activity is by military authorities the relevant data remains classified. It is thus impossible to ascertain what kind of evidence has been used in order to check the validity of estimates. However, informal estimates are that the UXO found between 1945 and the present day accounts for about

Monthly bomb tonnage dropped, by countries—Continued

ITALY AND SICILY

Year and month	USAAF	RAF	Total	Year and month	USAAF	RAF	Total
1940:				1943—Continued			
June.....		26	26	March.....	294	316	610
July.....		6	6	April.....	1,131	1,181	2,312
August.....		194	194	May.....	3,500	653	4,153
September.....		16	16	June.....	2,372	1,452	3,824
October.....		12	12	July.....	10,694	5,389	16,083
November.....		95	95	August.....	10,754	8,193	18,947
December.....		61	61	September.....	13,293	4,427	17,720
		410	410	October.....	5,925	2,396	8,321
1941:				November.....	4,297	1,793	6,090
January.....		101	101	December.....	6,774	764	7,538
February.....		28	28		59,642	27,354	86,996
April.....		1	1	1944:			
July.....		26	26	January.....	13,256	1,560	14,816
August.....		27	27	February.....	7,773	3,441	11,214
September.....		294	294	March.....	13,049	3,443	16,492
October.....		104	104	April.....	11,958	3,431	15,389
November.....		151	151	May.....	25,088	3,444	28,532
December.....		120	120	June.....	17,660	4,941	22,601
		852	852	July.....	12,537	6,303	18,840
1942:				August.....	9,009	7,628	16,637
January.....		52	52	September.....	10,321	9,524	19,845
February.....		38	38	October.....	9,021	3,146	12,167
March.....		3	3	November.....	10,759	2,334	13,093
April.....		30	30	December.....	8,711	3,037	11,768
May.....		31	31		149,142	52,252	201,394
June.....		38	38	1945:			
July.....		1	1	January.....	7,661	2,973	10,634
August.....		15	15	February.....	11,158	5,027	16,185
October.....		669	669	March.....	9,109	6,996	16,105
November.....		1,097	1,097	April.....	32,334	11,345	43,679
December.....		564	598	May.....	26	38	64
	34	2,538	2,572		60,288	26,379	86,667
1943:				Country total..	269,106	109,785	378,891
January.....	178	96	274				
February.....	430	694	1,124				



12.2 Top: Monthly bomb tonnage dropped on Italy and Sicily 1940–45; bottom: the overall distribution of bomb tonnages (Bombing Survey 1947)

60 per cent of the total at the end of the war. On this approximate basis it is possible that there are still about 15,160 tons of unexploded aerial bombs left in the landscape ($\pm$ 32,000–40,000 items); of 257,668 UXO found in 2007–10, 816 were aerial bombs (Fornaciari 2013). However, ANVCG data drawn from the Ministry of Defence records 60,000 pieces of explosives recovered every year in Italy, mostly of World War II date. This figure undermines the reliability of these counts of remaining UXO, and highlights the need to address the problem with a more accurate methodology and at a national level.

The need for national assessment is demonstrated by the fact that areas where UXO may be discovered are not only those where major offensives were fought (for example the coast of Sicily, the coast of Salerno, Cassino, Anzio and others), but also cities, harbours, stations, marshalling yards and railway bridges, major roads and railways, especially those used by the retreating German columns after the 8 September 1943 armistice. Moreover, bombers that for some reason had not achieved their mission would jettison their bomb load in order to decrease weight and land safely on returning to base. This means that UXO can be present almost anywhere, even in the (then) most remote countryside, which may today be densely urbanised. The long period of peace since 1945 has erased the immediate feeling of danger and it is widely believed that remaining World War II bombs are corroded and harmless scrap. On the contrary, explosives degrade very slowly and can remain active for hundreds of years, while deterioration of the mechanical parts makes them even more sensitive and at times even more dangerous. Thus, in 2013 alone 11 people were severely injured, with three deaths in the recent years (source: ANVCG). Workers on construction sites know that the risk is real, and for this reason Italian law requires a preliminary search for UXO before starting excavations and earthworks, though UXO also turns up during works not preceded by any assessment. Clearing ordnance is complex and expensive. The legal background and logistical problems are well explained in Gironi's dissertation (Gironi 2011), which is useful also for accurate statistics on UXO finds in northern and central Italy. The detection of UXO, typically found buried in the ground, but also in other places such as roof spaces, is usually undertaken through magnetic and electromagnetic geophysical survey. False alarms may be produced by harmless metallic objects. But the detection operation, not to mention the retrieval and demolition, is extremely expensive, even when the final result is negative.

Italian legislation, specifically Decree 81/2008 on civilian safety at work and L.177/2012 specify that preventive, systematic clearance should take place after obtaining the obligatory advice of the 'military responsible for the area, which considers the geographical location and the type of land'. It emphasises the responsibility of those working on the site, requiring the identification of any possible threat to public and personal safety, while the coordination and execution of the clearance is the exclusive competence of the Ministry of Defence, who may provide it directly or via specialised Bonifica Campi Minati (BCM, that is mine field reclamation) firms.

Law number 177/2012 requires each project to have a *Coordinatore Sicurezza* in fase di Progettazione (CSP, that is safety officer), a professional who can be an architect, engineer, geologist or surveyor, to proceed with a preliminary risk assessment of the presence of UXO, in order to establish the need to carry out clearance (and to plan the necessary budget).

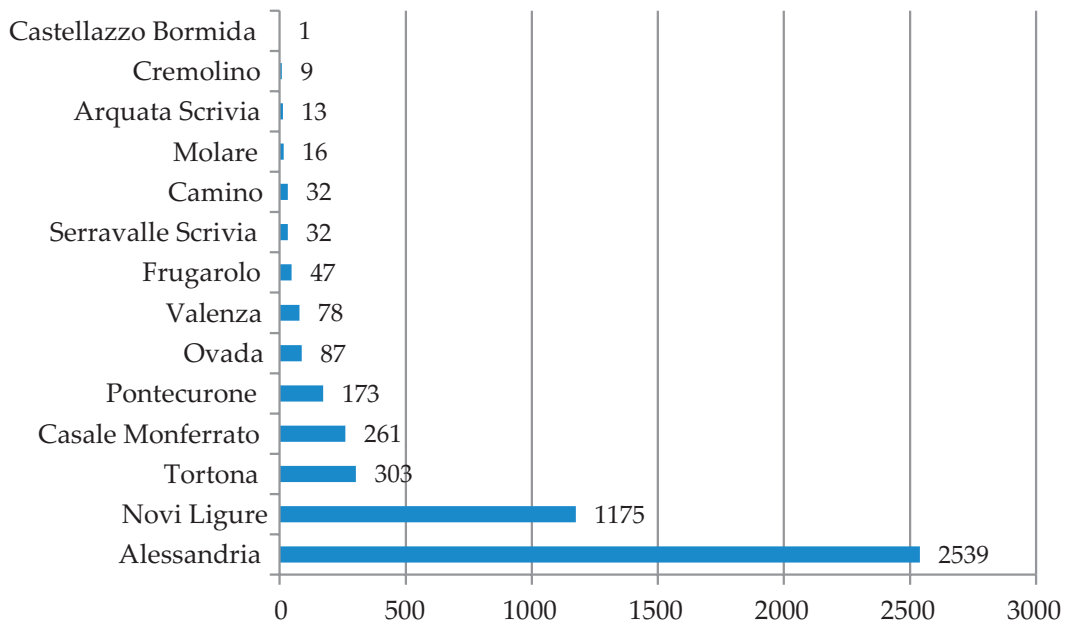
To produce a risk assessment, the safety officer (CSP) must apply to the appropriate military authority for their area (the 5th Reparto Infrastrutture – Coordination Unit – in Padua for northern Italy or the 10th Reparto Infrastrutture in Naples for central-southern Italy and the islands) requesting formal advice on the necessity of a UXO survey. The military authority will provide binding advice on the technical rules to be observed, based on assessment of geographical location, type of land and available historical information. Surprisingly, given the wealth of potential information on aerial photographs outlined above, only exceptionally does this include data derived from historical aerial imagery.

If there is a need for a preventive survey (either surface or deep ground), the developer is required to appoint a specialised BCM firm. In a surface survey (to a maximum depth of 1 metre) metal detectors are used and markers placed to identify potential targets. Where greater ground penetration is needed a deep-ground survey is conducted with the aid of detectors lowered into boreholes made by non-percussion drills. If the survey gives a negative result, the military authorities will organise a final test, after which the BCM company will issue a warranty, followed by an inspection report from the competent Reparto Infrastrutture, that will allow the start of construction works.

When UXO is detected, clearance on site or removal for subsequent destruction are undertaken exclusively by military engineers (EOD teams, explosive ordnance disposal) at the expense of the state. In delicate or dangerous operations, especially when there is a risk to civilians from an explosion, orders for road closures, diversion of air transport or evacuation of homes within a given radius may be issued. Between 2000 and 2012 the Army EOD groups performed 34,907 specialised interventions in Italy (Lafirenze 2013), an average of 2,685 per year. Between 2006 and 2013 the 32nd Engineers Regiment, in charge of UXO removal in Piedmont, Liguria and Valle d'Aosta (a total area of 34,000 square kilometres), has carried out 850 interventions, with a total of 2,600 pieces of ordnance destroyed (Zonzin 2013). Beyond the continuing human cost of UXO in Italy, there is clearly also a massive financial burden on construction works and the state from this legacy.

Aerial Photographs and UXO: An Under-appreciated Resource?

It has already been commented that aerial photographs should be a self-evident source of information to deal with UXO, but that this appears not to be the case. With its extensive record of the Italian landscape during the war, the MAPRW aerial photographs in Rome constitute one of the most important

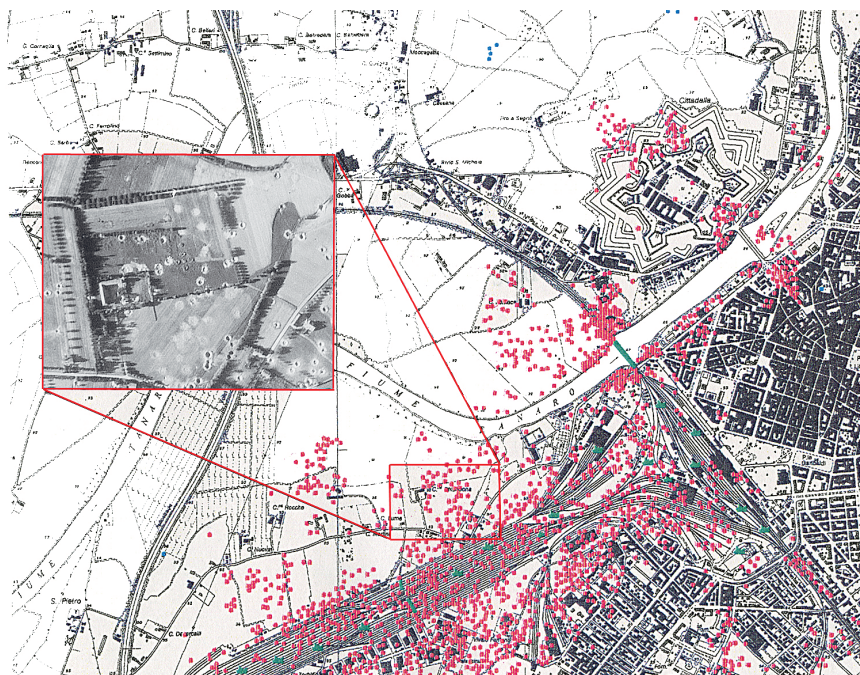


sources for mapping prospective UXO areas, but this potential is not being exploited. Indeed, in the last 12 years AFN has received only five requests for copies of photographs for this purpose. The requests were from two provinces, an inter-professional committee for safety on construction sites, and two private companies.

Of the two most significant projects, one was an analysis based on photo-interpretation and bibliographic research aimed at identifying risk areas for UXO undertaken by the Province of Alessandria's Civil Protection Service in 2001. This established that of its 190 *Comuni* (municipalities), 65 have useful documentation related to World War II bombing (51 had only a bibliography; 13 had photographs and bibliography; one had only photographs). The project found information for 4,766 bomb craters, and two large areas with many craters that were impossible to number individually. Aerial photographs gave information for 14 *comuni* (Figure 12.3), many of which suffered repeated bombing, as in the case of the city of Alessandria (Figure 12.4). This provided a basis for a risk assessment of the presence of UXO on the basis of four categories (high, medium-high, medium-low, low), in which 'low' does not indicate a low risk of UXO, but rather the total lack of available documentation. The project produced a searchable database, rich in geographical and historical information, with digital maps of the risk areas and documentation of sources, the locations of craters, and a colour-coded representation of the different levels of risk. However, the database is no longer active as it is technically outdated, and since it was only rarely consulted there is presently no intention of migrating its contents elsewhere (pers. comm. M. Robbiano, Provincia di Alessandria).

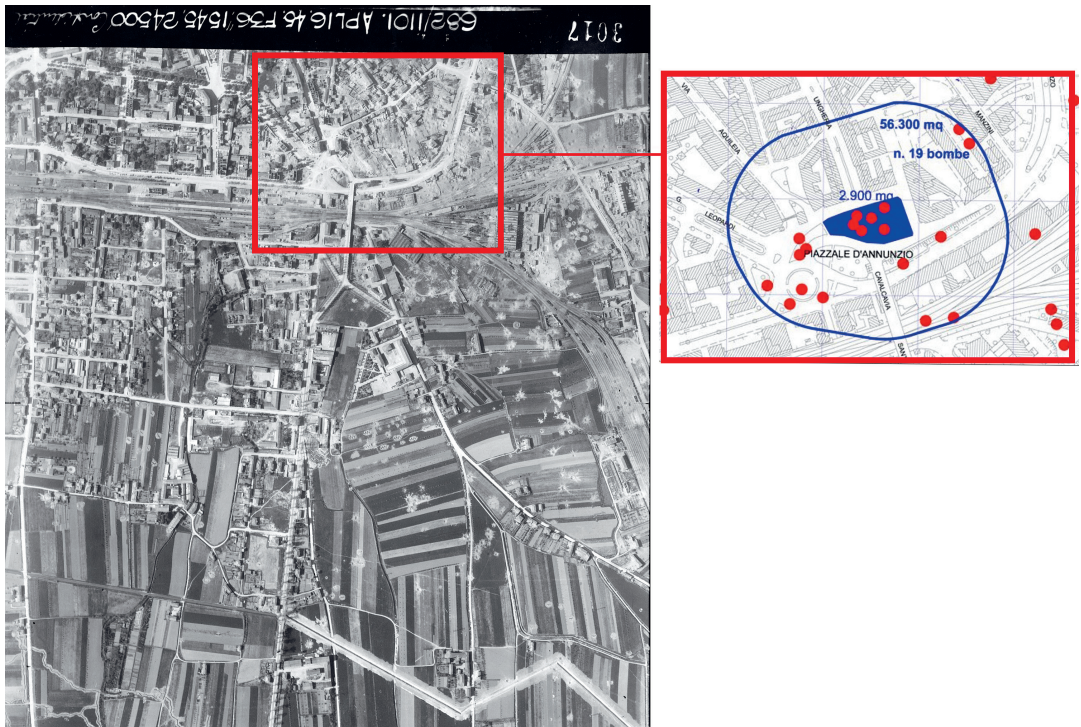
12.3 Provincia di Alessandria Project: known number of bomb craters. Source author

12.4 Bomb craters mapped on the *Carta Tecnica Regionale*, with the inset showing an extract of the source imagery (ICCD, AFN. MAPRW 5CM/1145ADB, 4029, 03/09/1944). By permission of the Istituto Centrale per il Catalogo e la Documentazione – MiBACT



The second noteworthy project is a recent initiative by the inter-professional committee for safety in construction (CISC) for the Province of Udine (Regione Friuli Venezia Giulia). After the publication of the L.177/2012 the CISC examined the issues of identification, discovery and the probability of explosion of ordnance found in the course of excavation activities. The CISC research points out clearly the absence of a national UXO predictive map for wartime ordnance, despite the fact that there is plenty of official documentation on the intensive bombing and military actions in Friuli-Venezia Giulia between September 1943 and April 1945. They also identified the necessity of using shared parameters in risk evaluation that would help the work of safety officers (CSP) on construction sites. CISC held a conference in Trento on these issues in May 2013, with proceedings and a wealth of documentation provided by institutions, organisations and firms working in this sector (CISC 2013). The AFN collaborated in the project, providing information and MAPRW imagery.

Both projects, though spaced in time and at different stages of completion, shared the same practice in historical research, looking to build a broad historical framework and drawing on other examples of good practice on the best ways of collating sources and maximising their value. Underpinning this approach is the recognition that to arrive at useful data to inform risk assessment, many fundamental sources of information must be compiled to establish whether a location was bombed, and why, how often and with what kind of bombs? The sources include wartime memoirs, archives in Italy (that is parish registers, the Provincial Committees for Anti-aircraft Protection,



prefectures, state and municipal archives, Army archives) and abroad (that is Allied forces, soldiers' diaries and post-war memoirs), databases of associations and organisations (such as CISC) and specialised websites (for example veterans' sites, the database of the US Air Force Research Institute, especially the Theater History of Operation Records (THOR) as it provides a quick and reliable way to view airstrike dates and a historical summary). The combination of historical data and quantitative (statistical and/or numerical) and qualitative (that is risk matrices) analyses supports the creation of risk assessment tools, but is also a new way of writing history.

Having followed this line of research, the CISC-Udine project successfully demonstrates the potential information on AFN's wartime photographs. Examination of just two images (ICCD-AFN, MAPRW 4110, 21/03/1945 and 3017, 16/04/1945) led them to detect 647 craters across an area of 525 hectares, amounting to 1.23 bombs/ha (Figure 12.5). This spatial information is supplemented by military history that records nine episodes of bombing of Udine between 1943 and 1945. For each event much information, official or private, is available and can be put to use for the detection of UXO. Research in Friuli-Venezia Giulia can also avail itself of data from the 5th Reparto Infrastrutture in Padua's BCM office that records 1,890 reports from between 1947 and 2008, resulting in over 11,000 UXO. Of the 1,890 reports of UXO discoveries, 621 occurred following 1,266 preventive surveys, while 1,269 were the result of random occurrences (Fornaciari 2013).

12.5 ICCD, AFN. MAPRW photo of Udine, 16 April 1945, with inset showing bomb craters mapped on the *Carta Tecnica Regionale* (Fornaciari 2013)



12.6 Ala, Trento. Bomb craters mapped from World War II aerial photographs displayed against a 1993 image showing the extensive urbanisation of this area (Finotti and Tonelli 1997)

Taking another example from the Regione Autonoma Trentino-Alto Adige, a small sample of bomb crater mapping from World War II aerial photographs (in part from AFN), this time as an overlay on 1993 photographs (Figure 12.6), was published in 1997 by the Museo Storico in Trento (Finotti and Tonelli 1997: 74). A few years later Trentino conducted a much more complex project (UXB-TN) using imagery from the NARA and TARA/NCAP archives. The UXB-TN (that is Unexploded Bombs-Trento) project mapped UXO in the Regione Autonoma Trentino-Alto Adige with the assistance of a group coordinated by Cesare Furlanello of the Bruno Kessler Foundation, in collaboration with the Government Commission of Trento, the Army Corps of Engineers and UK-based Cambridge Architectural Research Ltd (Furlanello et al. 2004, Merler et al. 2005).

Trentino Alto Adige (provinces of Trento and Bolzano) suffered heavy air attacks in the last seven months of the war during the retreat of the German army. In the province of Trento alone at least 32,019 explosive, fragmentation, incendiary and cluster bombs were deployed, and of these, about 800–1,280 UXO were left on the ground. Given the importance of this problem, the Civil Protection in Trentino decided to develop a tool to assist in risk prediction. Firstly, a wide range of historical information was compiled, combining the original mission data with what could be read from aerial photographs, with the products delivered through a webGIS (Progetto UXB 2015). The UXB-TN project is particularly innovative because, in addition to using the usual methods of photo-interpretation and associating geo-referenced data on maps, it integrated them with a statistical machine learning system for automated recognition of bomb craters (Merler et al. 2005). Since 2002 the result is a webGIS that can be easily interrogated, allows the consultation of detailed risk maps and aerial photographs, and generates different sorts of written reports.

Conclusion

The aftermath of conflicts can continue for many decades, and the legacy of the intensive bombing of Italy during World War II is still being felt over 70 years after the end of hostilities. A limited number of projects demonstrate that World War II aerial photographs, and specifically AFN's MAPRW images, have a high information potential for exploring conflict landscapes and mapping of bombed areas. These are, however, not a universal panacea, nor without complications. On the positive side there are large numbers of clearly useful photographs, often with repeat photography that allows analysis of the stratigraphy of bombing. However, the incompleteness of the collection due to selections made in 1945 and the military imperatives for photography (for example reconnaissance and intelligence targeting, but not necessarily also bombing assessment) may be a limitation, which can be compounded by the large number of photographs, whose assessment requires considerable resources, including the expenses of digitisation, georeferencing and conservation (Palazzi 2011).

Examples of projects using aerial imagery to define potential UXO hazards demonstrate the value of mapping from aerial photographs to provide a solid knowledge base, easily upgraded over time with other historical sources. The ICCD intends to define a national project, in agreement with civil and military authorities, and extending to all with an interest in historical knowledge, the protection of the Italian landscape and the personal safety of all those who live in it. To do this it is necessary to share information, using modern technology, through consistent and regulated functions that deliver images and information in easily accessible and flexible ways, preferably through the WMS services of the Geoportale Nazionale. Underpinning this

approach is the recognition of the value of the wartime imagery to protect the contemporary population and to mitigate the costs of redevelopment and construction works. The aerial photographs that were such a central part of the wartime military activity thus have a very real dividend in dealing the continuing problems of UXO in a contemporary landscape.

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References

- Baldoli, C. (2010) I bombardamenti sull'Italia nella Seconda guerra mondiale. In B. Bianchi, M. Cangiani and F. Coin (eds) *La violenza sugli inermi. La trasformazione dei conflitti dalla Grande guerra a oggi*. DEP – *Deportate, esuli e profughe* 13/14: 34–49.
- Bombing Italy (2015) *The Bombing of Italy 1940–1945 Exhibition*. University of Exeter Centre for the Study of War, State and Society. http://humanities.exeter.ac.uk/media/universityofexeter/collegeofhumanities/history/researchcentres/centreforthestudyofwarstateandsociety/bombing/THE_BOMBING_OF_ITALY.pdf (retrieved 5 March 2015).
- Bombing Survey (1947) *The United States Strategic Bombing Survey: Statistical Appendix to Over-All Report (European War)*. Washington, DC: s.n.
- Ceraudo, G. and E.J. Shepherd (2010) Italian Aerial Photographic Archives: Holdings and Case Studies. In D.C. Cowley, R.A. Standring and M.J. Abicht (eds) *Landscapes Through the Lens: Aerial Photographs and the Historic Environment*. Occasional Publication of the Aerial Archaeology Research Group No. 2., pp. 237–46. Oxford: Oxbow.
- CISC (2013) *Documenti ordigni bellici*. <http://www.ciscudine.it/documenti-prodotti/ordigni-bellici> (retrieved 5 March 2015).
- Cowley, D.C., L. Ferguson and A. Williams (2013) The Aerial Reconnaissance Archives: A Global Aerial Photographic Collection. In W.S. Hanson and I.A. Oltean (eds) *Archaeology from Historical Aerial and Satellite Archives*, pp. 13–45. New York: Springer.
- Cowley, D.C., R.A. Standring and M.J. Abicht (eds) (2010) *Landscapes Through the Lens: Aerial Photographs and Historic Environment*. Occasional Publication of the Aerial Archaeology Research Group No. 2. Oxford: Oxbow Books.
- Cowley, D.C. and B. Stichelbaut (2012) Historical Aerial Photographic Archives for European Archaeology: Applications, Potential and Issues. *European Journal of Archaeology* 12(2): 217–36.
- Finotti, F. and A. Tonelli (1997) Note sull'utilizzo delle foto aeree. In D. Leoni and P. Marchesoni (eds) *Lo sguardo del sapiente glaciale. La ricognizione aerofotografica anglo-americana sul Trentino (1943–1945)*, pp. 72–5. Trento: Museo Storico in Trento.

- Fornaciari, C.S. (2013) La ricerca storica preliminare. Dati, fonti, strumenti per l'analisi e la valutazione del rischio. Paper presented at the seminar Il rischio associato al rinvenimento di ordigni. Rinvenimento di ordigni bellici inesplosi, Udine, 15 May 2013.
- Furlanello, C., S. Merler, S. Menegon, E. Paoli and S. Fontanari (2004) Mapping the Risk of Unexploded Bombs from World War Two. In M.A. Brovelli (ed.) *3rd and 4th Italian GRASS Users Meeting Proceedings: Geomatics Workbooks*, pp. 1–2. Triest and Firenze: Laboratorio di Geomatica.
- Gioannini, M. and G. Massobrio (2007) *Bombardate l'Italia. Storia della guerra di distruzione aerea 1940–1945*. Milano: Rizzoli.
- Gironi, D. (2011) *Aspetti operativi ed evoluzione normativa della sicurezza in cantiere: indagini preliminari del sito e bonifica da ordigni bellici inesplosi. Tesi di laurea Università di Bologna, Facoltà di Ingegneria*. Bologna: Gironi.
- Hanson, W.S. and A. Oltean (eds) (2013) *Archaeology from Historical Aerial and Satellite Archives*. New York: Springer.
- Labanca, N. (ed.) (2012) *I bombardamenti aerei sull'Italia*. Bologna: Il Mulino.
- Lafrenze, G. (2013) *Artificieri disinnescano bomba della II guerra mondiale*. <http://biografiadiunabomba.blogspot.it> (retrieved 10 February 2015).
- Merler, S., C. Furlanello and G. Jurman (2005) Machine Learning on Historic Air Photographs for Mapping Risk of Unexploded Bombs: ICIAP 2005 – Image Analysis and Processing. *Computer Sciences* 3617: 735–42.
- Museo Torino (2015) *Bombardamenti a Torino*. <http://www.museotorino.it/view/s/acb7d7d49d6147e188377fb9e9c491ef> (retrieved 5 March 2015).
- Palazzi, D.S. (2011) Strategie di conservazione dei fondi 'compositi' dell'Aerofototeca Nazionale-ICCD. XVIII Salone dell'Arte del Restauro e della Conservazione dei Beni Culturali e ambientali, Ferrara, 31 March 2011.
- Progetto UXB (2015) *Rischio ritrovamento bombe inesplose*. http://www.protezionecivile.tn.it/territorio/Progetto_uxb/-categoria1/pagina1.html (retrieved 20 February 2015).
- Shepherd, E.J., D.S. Palazzi, G. Leone and M.M.M. Mavica (2012) La collezione c.d. U.S.A.A.F. dell'Aerofototeca Nazionale. Lavori in corso. *Archeologia Aerea* 6: 13–32.
- US Department of Defense (2003) *Report of the Defense Science Board Task Force on Unexploded Ordnance*. Washington, DC: Office of the Under Secretary of Defense for Acquisition, Technology and Logistics.
- Zonzin, S. (2013) *Gli ordigni bellici inesplosi. Pericolosità e norma di comportamento*. <http://www.itadalmasso.org> (retrieved 20 February 2015).



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Erased Landscapes: Conflict, Memory and Post-World War II Landscape Transformation in Western Poland

Grzegorz Kiarszys

Abstract

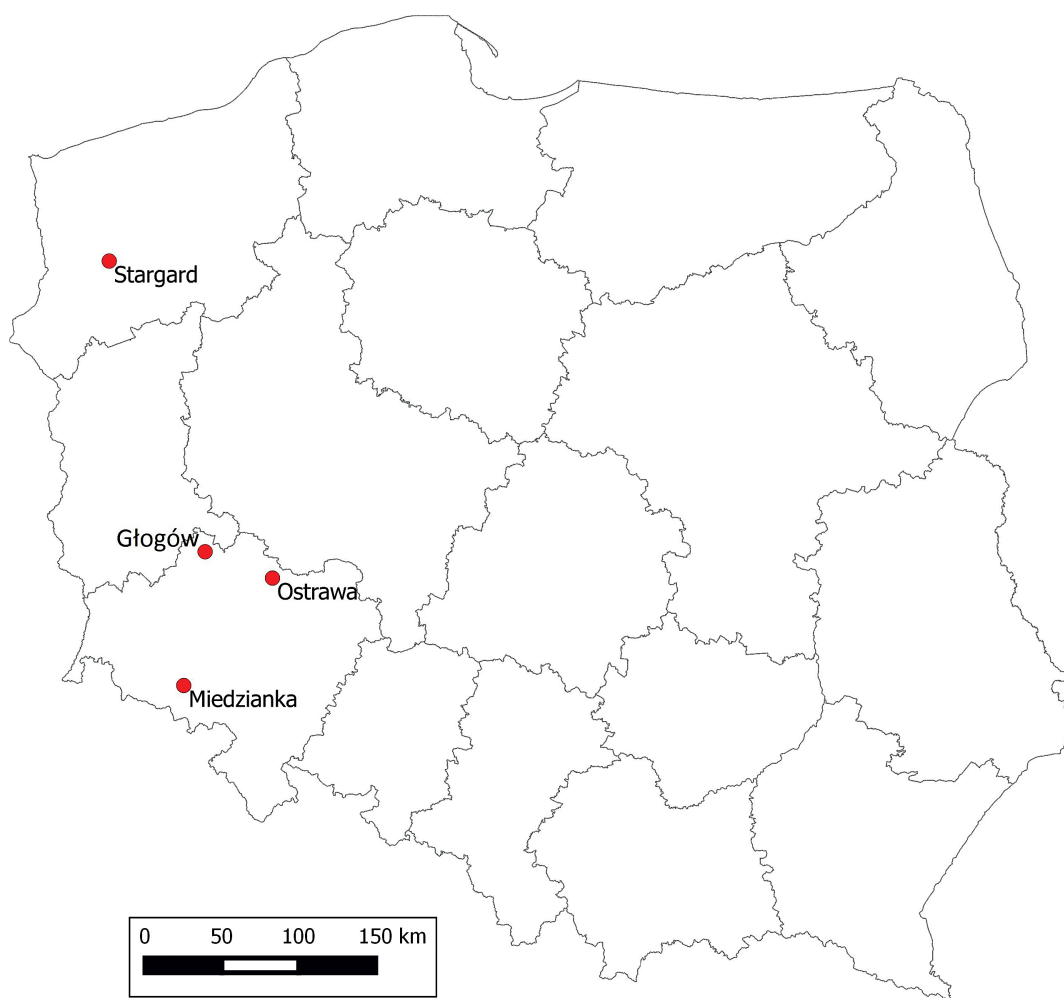
This chapter presents selected examples of landscape transformations that took place in western Poland after World War II. My interpretations will be based on archival and contemporary aerial photographs, Airborne Laser Scanning (ALS) data and historical sources. The cultural landscape of western Poland after World War II was a product of discourse based on opposition and denial in relation to German culture. It was a subject of propaganda driven by the need to justify border changes. That destructive process reflects not only the new political order, but also major changes in the understanding of values such as national identity, tradition and cultural heritage.

Keywords: conflict, cultural landscape, transformation, Cold War, aerial photography, Airborne Laser Scanning.

Introduction

When we think about landscape transformations caused by conflicts we often tend to associate them with open military confrontations. The first ideas that usually come to our minds are well known images of battlefields of World Wars I and II recorded in old photographs. Those persuasive images of destruction, frequently reproduced by mass media, have shaped the popular understanding of these events and processes.

However, beside military conflicts there is a spectrum of other socio-cultural states that can be also associated with conflicts (for example Anderson and Taylor 2013: 44–5, Turner 2004: 175–282, MacDonald 2009). The majority of them may have an impact on material culture or on the form of cultural landscape. Some socio-ideological conflicts are an aftermath of wars as military confrontations



13.1 Location of sites/landscapes discussed in the text.
© G. Kiarszys

do not simply end with the last shot being fired and a peace treaty signed by politicians. They leave their burden in social memory and mentality, influencing the lives of following generations and their material reality. Such conflicts last longer, only their forms and methods are changing.

This chapter discusses selected examples of landscape processes that took place in western Poland after World War II (Figure 13.1) illustrated by three case studies of townscape and two examples of rural landscapes that have undergone deep transformations. The different socio-ideological contexts will be presented alongside the various factors that determined their post-war arrangement.

The new form of the cultural landscape of the western territories of Poland can be seen as a result of both post-war 'reconstruction' and ideological struggle. The latter process reflects not only the introduction of socialism, but also major changes in the understanding of values such as national identity,

tradition and cultural heritage. Following the ideas of Samuel P. Huntington (1957: 454) ideology is understood as '... a system of ideas concerned with the distribution of political and social values and acquiesced in by a significant social group'. The examples of ideological conflict presented in this chapter emerged from the profound incompatibility between historically shaped cultural landscape and the introduction of the new social order.

The Fall of the City

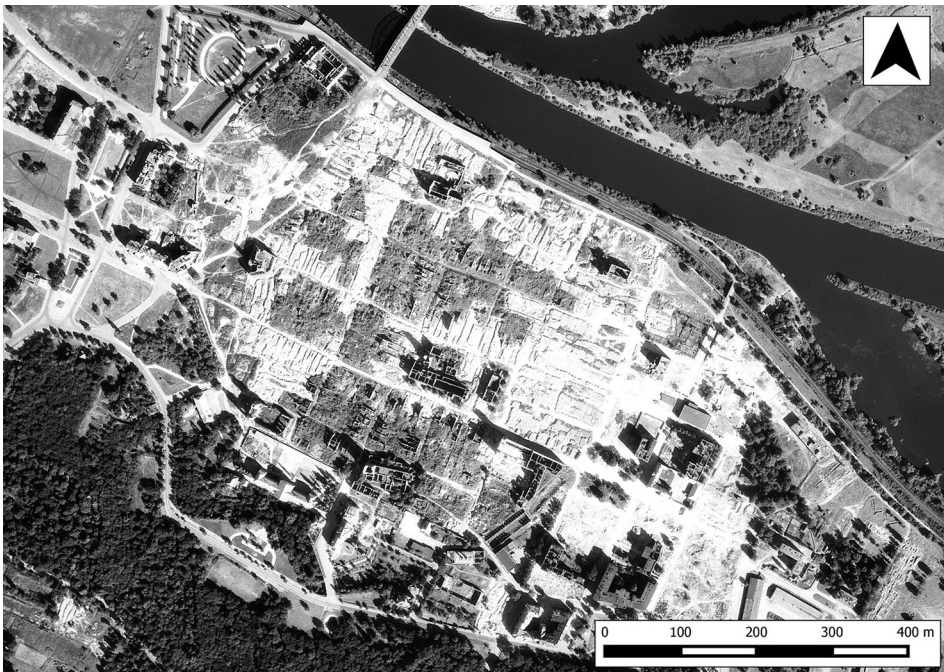
The inspiration for this chapter was the aerial photographs of the historical city centre of Głogów (German: Glogau), Lower Silesia Region ([Figure 13.2](#)). At first glance it may seem that it is just one of many photographs of a city ruined during World War II. We might assume that the photograph was taken just after the war. Since most of the ruins look quite 'fresh'. However, significant effort had already been made to clear the streets and remove the rubble.

In fact, which may be surprising, this aerial photograph was taken in 1959, 14 years after the war! At that time Głogów was already an important centre with a rapidly growing population. Some districts of the city were already rebuilt. However, the historical medieval centre of Głogów that was of great cultural value for some reason was left almost in the condition it was at the end of the war. This great destruction lies in events which occurred 14 years earlier. Following orders issued in July 1944 by Adolf Hitler, Głogów was turned into a fortress, and during the last months of World War II in Europe it shared the fate of many other towns of strategic importance. After months of preparation the city was desperately defended against the advancing Red Army (Ożóg 2009, 2010a).

A German aerial intelligence photograph of Głogów taken on 16 March 1945 ([Figure 13.3](#)) survives in the GX collection of TARA archives in Edinburgh. It records in great detail the extent of devastation. Only a very few buildings still had roofs, others are only roofless empty burnt-out shells. Most of the architecture was already ruined. The smoke rising over the city indicates that some of the buildings were on fire when the photograph was taken. The following days of the siege brought complete destruction of the city. Air raids, artillery barrage and heavy street fighting turned it into rubble. Finally, after six weeks of siege, on 3 April 1945, the city was officially surrendered to the Red Army.

During the Communist era very few buildings were built within the historical city centre of Głogów (Ożóg 2010b: 119, 123–5, 2010c). Even until very recently the larger part of the old city was empty and ruins were still visible ([Figure 13.4](#)). This situation started to change only about five years ago.

Most of the towns of contemporary western Poland, that happened to be located in the frontline areas, shared a similar destiny. After the war they either underwent extensive transformation or were completely demolished. Most of them were never restored to their previous state.



13.2 Historical city centre of Głogów in 1959. © CODGiK



13.3 German aerial intelligence photograph of Głogów taken on 16 March 1945. © NCAP / ncap.org.uk



The aim of post-war 'reconstruction' in Communist-ruled Poland was in fact more about transforming the landscape so it could fulfil the new ideological requirements than about restoring the old spatial patterns.

13.4

Contemporary aerial photograph of the historical centre of Głogów.
© W. Rączkowski

'Regained Territories': Historical Background

After the end of World War II Poland fell under the control of the Soviet Union for over four decades. Due to decisions made during the conferences in Yalta and Potsdam the western and eastern borders of Poland were changed without any consideration given to the Polish Government in exile in London. Poland lost large territories in the east and gained as 'recompense' some territories to the west and north that previously belonged to Germany. The new territories of western Poland were called by Communist propaganda the 'regained territories' (Rączkowski 1996: 208).

Ruined and plundered former German towns and villages were placed under the Polish administration. Polish settlers from the eastern part of the country were forced to leave their homes behind and replace German inhabitants, who were ruthlessly exiled. Significant numbers of new Polish settlers from the central territories arrived voluntarily, due to the information campaign that presented the 'regained territories' as full of rich farms and fertile lands. However, what they found did not match the promised land featured in the propaganda.

The architecture of the settlements from the 'regained territories' was considered by the Communists as 'German' or 'culturally alien' (for example

Kijowska et al. 2010) even though it did not differ significantly from the architecture of some Polish towns and villages in neighbouring regions. Thus, post-war 'reconstruction' driven by war trauma and Communist ideology became as destructive as the war itself. It went far beyond just physical transformation of the cultural landscape. It was meant to influence and restrict every possible field of social life, tradition and social memory.

Cultural Landscape as a Field of Political Discourse

The purpose of most forms of material culture is mnemonic and discursive (for example Jones 2007), and architecture is often a key to understanding national identity (Tuan 1987: 204–47). The cultural landscape of the 'regained territories' became a product of the discourse based on opposition and denial in relation to German culture (for example Rączkowski 1996: 208–13). It was a subject of propaganda driven by the need to justify border changes.

In totalitarian systems political elites limit the means of social discourse. Allegiance to a dominating ideology and a confined group of decision-makers leads to unification of social life in restrictive ways (MacDonald 2009: 223–4). This tendency is especially clear in the case of landscape order and spatial patterns that are remains of the Cold War era.

In certain historical circumstances social memory can be altered through the appropriation or destruction of meaningful cultural places. Deliberate destruction of pre-World War II symbols or replacing them with new, ideologically correct features was designed to erase the memory about the previous inhabitants of those lands.

As a result, during the reconstruction process towns and villages were 'rebuilt' in a way that completely changed their appearance. Old town houses were replaced by modernist architecture. Historical town centres especially underwent such 'reconstruction' and lost their historical meaning and function. Some settlements were never rebuilt. Rural landscapes also suffered from vast transformations. Many manor houses owned by German gentry were dismantled, while others were turned into communal farms or public buildings such as schools and hospitals. Land cultivation changed significantly together with the system of arable land ownership.

Stargard: Transformed Landscapes, Erased Memories

Stargard (German: Stargard in Pommern) is a city in the province of Western Pomerania. Before World War II it had a characteristic medieval spatial pattern, with a walled historical centre and an early modern fortification system (Figure 13.5). At the turn of the twentieth century it was an important industrial and trade centre, containing rich examples of Gothic and Renaissance architecture (for example Augustyn-Lendzion 2008: 8, Rutyna 2011).



13.5 Historical city centre of Stargard in 1938. © NCAP / ncap.org.uk

The Red Army captured Stargard on 5 March 1945. There was no fighting in the city as the main German armed forces were recalled for the defence of nearby Szczecin. Only the modern part of the city was bombed in air raids and the historical centre survived in a very good state. However, over 10 days later, when most of the town buildings had already been plundered of their valuables, the old city of Stargard was burned to the ground in a fit of rage by Red Army soldiers. This happened over a month after the Yalta Conference, where it was decided that Stargard would become a Polish city.

Before the war the city centre of Stargard had many social and economic functions. Beside residential areas, there were also production places and workshops such as a paper mill, weaving factory, several breweries, jewellerys, shoemakers and many others. The town market was a place of trade of local production and there was also a town harbour on the Ina River.

After the war the city centre lost all those functions, becoming just another residential district of the city. The socialist economy was unfavourable to any private initiative (both production and trade), and thus most economic activities had to be strictly controlled by the state. The old spatial patterns were compromised and the character and the function of the city were utterly redefined. Ruins of the old town houses were demolished and replaced with modernistic blocks of flats (Figure 13.6), while very few historical buildings were reconstructed (Augustyn-Lendzion 2008: 9, Rutyna 2011: 591).

Spatial patterns of human settlement can be interpreted as a reflection of the social microcosms of its inhabitants. They are also a material record of the continuity of culture. The hierarchical structure of a capitalist society, so clearly expressed through rich façades of town buildings, numerous private shops and manufacturing, as well as their spatial arrangement within the townscape, were ideologically unacceptable to the Communists. In the case of Stargard the cultural continuity was broken to reject the past of the city, as historical architecture was replaced by simple buildings with repetitive façades.

Miedzianka: The Landscape of Oblivion

In some circumstances an ideological conflict may become a destructive force that is able to erase whole settlements. Such was the case of the small town of Miedzianka (German: Kupferberg) in Lower Silesia Region.

Since its foundation Miedzianka was a town of copper miners (Madziarz 2009: 141–3, Siuda et al. 2010: 431–3, Garbacz-Klempka et al. 2013: 32–4, Springer 2011). When the copper resources were depleted in the nineteenth century it became a tourist resort well known throughout Prussia. The town was situated on the top of a hill in a very picturesque setting, and had a historical spatial pattern with a typical square market surrounded by town buildings.



13.6 City centre of Stargard in 1977. © CODGiK

The situation of Miedzianka did not change significantly when uranophane was discovered in the old mining shafts under the town in 1854. It could be not predicted that this rare mineral containing uranium, which was initially treated as waste, a century later would become an indirect cause of the destruction of the whole town. Miedzianka was not destroyed during World War II. The Germans did not exploit the uranium, even though they were clearly aware of the value of its resources. The town was not defended and was captured by the Red Army without a single shot being fired.

Soon after the war the town became a secret Red Army mining operation, codenamed 'Industrial Plants R-1', administered by the Army, with access to the site restricted. The uranium mine operated from 1948 to 1952 (Madziarz 2009: 145–7) with the main working force originating from the eastern and central regions of Poland, from where they were recruited with a promise of high salaries. Most of them, without any protective gear, were unaware of the unhealthy working conditions in the uranium mine (Springer 2011).

According to different sources it is estimated that about 14.7 tons of uranium ore were sent from Miedzianka to the USSR (Madziarz 2009: 160–62). In the late 1950s the spoil heaps from the uranium exploitation were reworked after it was realised that they contained high quality copper ore, a very valuable resource in the post-war industry.

In the late 1960s a political decision was made to demolish the town so that no material proof of the secret mining operation would remain. The local administration forbade renovation of buildings that started to fall into decay. The Protestant church and some other buildings were demolished. Eventually, after most of the residents were resettled to nearby Jelenia Góra (German: Hirschberg) the larger part of the town was levelled to the ground. Today only very few town buildings and the Catholic church still stand.

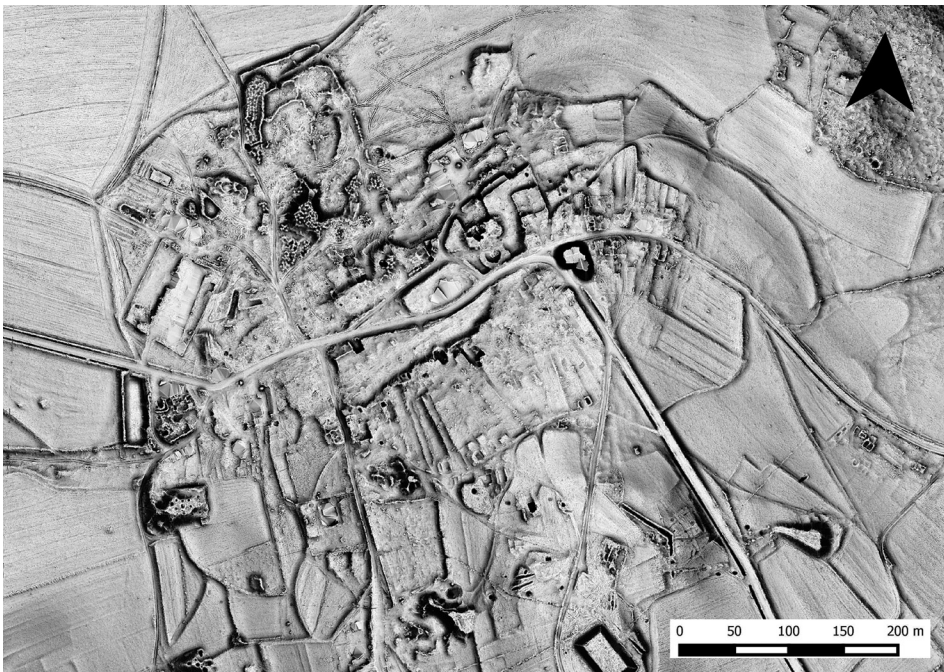
The aerial photograph taken on 27 September 1975 records the last chapter of the history of Miedzianka (Figure 13.7). Very few features show the remains of the demolished town and the market square is overgrown by dense wild vegetation. The radioactive spoil heap from the main uranium mine had already been removed.

More information about the remains of Miedzianka can be retrieved from a Sky View Factor (SVF) visualisation of ALS (Kokalj et al. 2011) (Figure 13.8). The market square is clearly visible as well as the footprints of town buildings. Even such features as vegetable gardens, minor mining shafts and numerous small spoil heaps can still be clearly identified.

However, the ALS recorded much more than just the relicts of Miedzianka. The whole surrounding landscape bears the remains of the past and can be seen as a heritage site. Alongside the destruction of Miedzianka many neighbouring farms that supplied the town with food also disappeared (Figure 13.9). Preserved field boundaries and numerous ruins of farm buildings scattered across the whole area show that the contemporary wilderness was not so long ago intensively cultivated land, full of arable fields and pastures.



13.7 Aerial photograph of Miedzianka taken on 27 September 1975. © CODGiK



13.8 The remains of Miedzianka. ALS SVF visualisation. © G. Kiarszys



13.9 Field divisions and ruined farms in the vicinity of Miedzianka. ALS SVF visualisation. © G. Kierszys

The Village of Ostrawa: Appropriation and Destruction

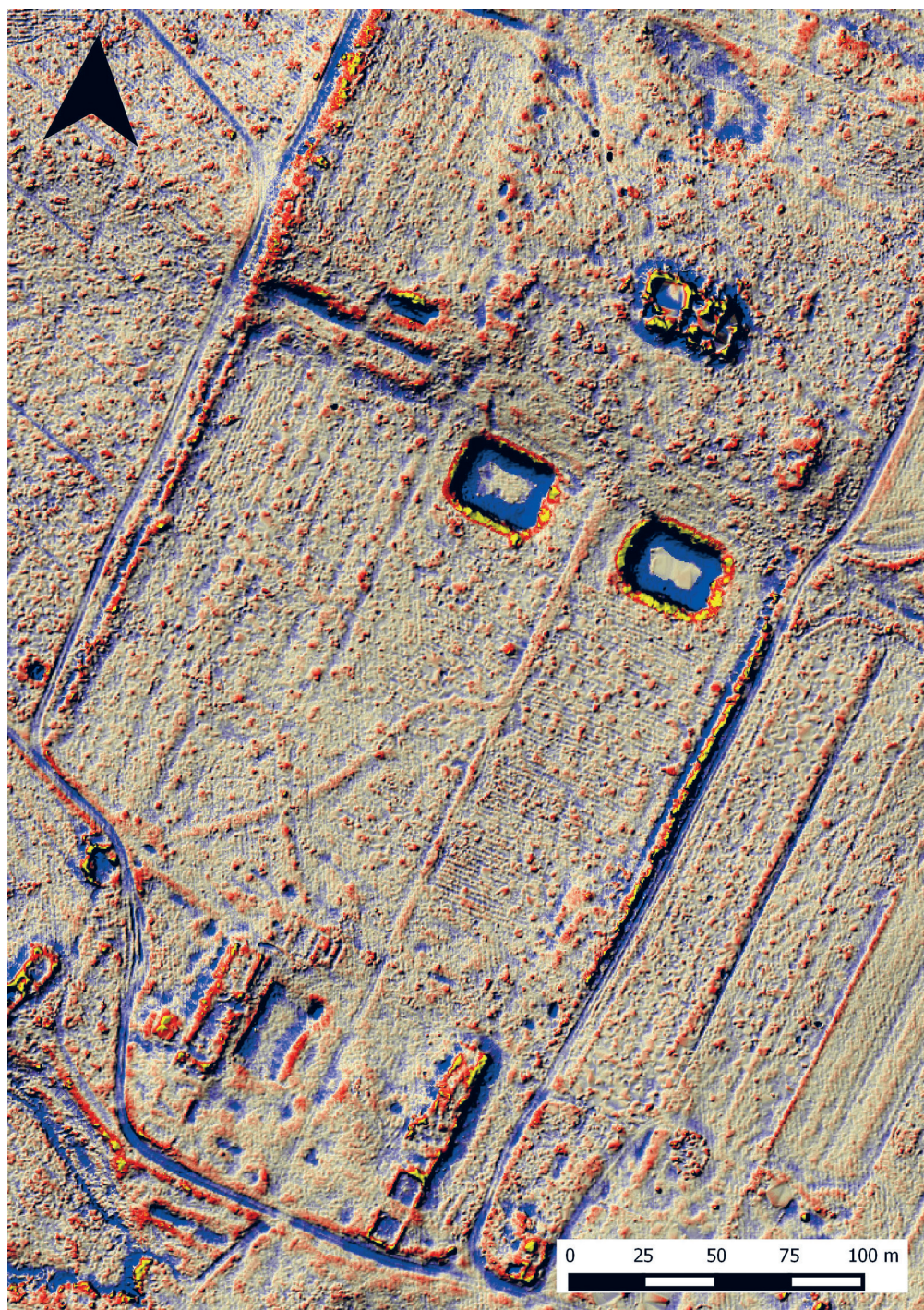
As a consequence of the land reform introduced by the Communist Government on 6 September 1944 large private farms, previously owned by local gentry were confiscated and divided between smaller landowners. Later, some big farms were converted into communal farms administered by the state. This process was especially intensive within the ‘regained territories’ where it did not meet any opposition due to the absence of the exiled owners (Kijowska et al. 2010: 158).

The village of Ostrawa (German: Ostrawe, Willenheim) in Lower Silesia Region is one such example. Before World War II there was a large grange and a manor house with a park adjacent to the village. Shortly after the war the manor house was plundered and the land was let out to newly-arrived Polish settlers. Due to the remote location of the grange the decision was made to dismantle some of the buildings as it was not going to become a communal farm. Thus it was perceived as economically useless, even though it was a heritage site with architecture dating back to the eighteenth century. The manor house had no purpose in the new ideological circumstances – it could not be returned to its former owners, nor acquire any meaning that would protect it from destruction.



13.10 The village of Ostrawa photographed on 23 July 1974. © CODGiK

Over time the whole place became overgrown by vegetation and the buildings gradually decayed. On the aerial photograph taken on 23 July 1974 some of the remains of the grange can still be recognised (Figure 13.10). Part of one farm building is still roofed, and the roofless manor house is also quite clear, as well as the outer boundaries and the main alley running through the middle of the site. Today all of those remains have disappeared under dense vegetation and cannot be identified from the air anymore, though more details of the remains of the grange from Ostrawa can be recognised in the visualisation created from the ALS data (Figure 13.11). One might not expect that so many micro-topographical features could survive to the present day, but the walls of the farm buildings seem to be preserved as well as the symmetrical outline of the alleys and two rectangular ponds situated on the two sides of the main road leading towards the manor house. The process of destruction that was very severe at the beginning seems to have slowed down.



13.11 The remains of the grange and manor house at Ostrawa. Combined Local Relief Model and Digital Terrain Model derived from ALS data. © G. Kiarszys

Conclusion

Most of the examples of landscape change caused by post-war transformation and Communist ideology are irreversible as cultural heritage sites, historical spatial patterns and architecture have been irrevocably lost. However, even complete destruction of important social places appears not to be enough to erase social memory. Polish culture has worked out many different ways of commemorating the past, and the archaeology of conflict functions as one such means. It can be a helpful instrument in rationalising conflicts and understanding their essence, while also producing a field for dialogue.

The image of a past landscape may live in the memories and traditions of people long after its physical destruction. The idea of cultural struggle seems to be still present in social discourse in western Poland, even though the political circumstances have changed significantly since the collapse of Communism in Europe. The myth of the conflict lasts longer, only its forms and methods have changed. Intentional destruction was replaced by indifference towards cultural heritage. Its value is rarely recognised or appreciated by local societies.

References

- Anderson, L.M. and F.H. Taylor (2013) *Sociology: The Essentials*. Wadsworth: Cengage Learning.
- Augustyn-Lendzion, E. (2008) Czy istnieje miasto bez serca? Przykład Stargardu Szczecińskiego. *Czasopismo techniczne: Architektura* 2: 7–13.
- Garbacz-Klempka, A., S. Rządkosz, T. Stolarczyk, J. Kozana and M. Piękoś (2013) Archaeological Remains of the Copper Metallurgy in Lower Silesia. *Metallurgy and Foundry Engineering* 39(2): 29–36.
- Huntington, S.P. (1957) Conservatism as an Ideology. *American Political Science Review* 51: 454–73.
- Jones, A. (2007) *Memory and Material Culture*. Cambridge: Cambridge University Press.
- Kijowska, J., A. Kijowski and W. Rączkowski (2010) Politics and Landscape Change in Poland: c. 1940–2000. In D.C. Cowley, R.A. Standring and M.J. Abicht (eds) *Landscape Through the Lens: Aerial Photographs and Historic Environment*, pp. 155–66. Oxford and Oakville, CT: Oxbow Books.
- Kokalj, Ž., K. Zakšek and K. Oštir (2011) Application of Sky-view Factor for the Visualization of Historic Landscape Features in Lidar-derived Relief Models. *Antiquity* 85(327): 263–73.
- MacDonald, K. (2009) Evolution, Psychology, and a Conflict Theory of Culture. *Evolutionary Psychology* 7(2): 208–33.
- Madziarz, M. (2009) Stan rozpoznania historycznie eksploatowanych sudeckich złóż polimetalicznych w świetle wyników powojennych prac geologiczno-poszukiwawczych. *Prace Naukowe Instytutu Górnictwa Politechniki Wrocławskiej* 36: 141–67.

- Ożóg, S.K. (2009) Zaginiona przestrzeń sakralna Głogowa. In S. Lisewska and M. Ożóg (eds) *Roczniki Naukowe Instytutu Humanistycznego PWSZ w Głogowie* 1, pp. 85–95. Głogów: PWSZ.
- (2010a) W poszukiwaniu utraconej tożsamości Miasta. Kilka przypadków powojennego Głogowa. In S. Lisewska and M. Ożóg (eds) *Roczniki Naukowe Instytutu Humanistycznego PWSZ w Głogowie* 2, pp. 85–94. Głogów: PWSZ.
- (2010b) Centrum zagubione, centrum odnalezione. Sytuacja urbanistyczna Głogowa w perspektywie historycznej. In M. Banaszkiewicz, F. Czech and P. Winskowski (eds) *Miasto między przestrzenią, a koncepcją przestrzeni*, pp. 119–28. Kraków: Wydawnictwo Uniwersytetu Jagiellońskiego.
- (2010c) Pomiedzy Głogowem a Glogau. Ewolucja postaw wobec szczątków dawnego miasta. In E. Pilecka and J. Raczkowski (eds) *Wobec zabytku ... Tradycje i perspektywy postaw. Studia dedykowane pamięci prof. Jerzego Remera*, pp. 168–85. Toruń: Wydawnictwo Naukowe UMK.
- Rączkowski, W. (1996) 'Drang nach Western?': Polish Archaeology and National Identity. In M. Díaz-Andreu and T. Champion (eds) *Nationalism and Archaeology in Europe*, pp. 189–217. London: UCL Press.
- Rutyna, H. (2011) Neogotycki kościół Ducha Świętego w Stargardzie Szczecińskim. Cz. 1.: Architektura. *Przestrzeń i forma* 16: 589–608.
- Siuda, R., R. Borzęcki, and B. Gołębiowska (2010) Hałdy dawnego górnictwa w rejonie Miedzianki-Ciechanowic jako stanowiska dokumentacyjne unikatowej mineralizacji hipergenicznej. In P.P. Zagożdżon and M. Madziarz (eds) *Dzieje górnictwa – element europejskiego dziedzictwa kultury* 3, pp. 431–41. Wrocław: Oficyna Wydawnicza Politechniki Wrocławskiej.
- Springer, F. (2011) *Miedzianka. Historia znikania*. Wołowiec: Wydawnictwo Czarne.
- Tuan, Y. (1987) *Przestrzeń i miejsce*. Warszawa: PIW.
- Turner, J. (2004) *Struktura teorii socjologicznej*. Warszawa: Wydawnictwo Naukowe PWN.

A Cold War Conflict Landscape in the Borderlands of West Bohemia

Michal Rak, Lukáš Funk and Lenka Starková

Abstract

This chapter discusses the formation of the Cold War landscape in the borderlands of West Bohemia during the mid-twentieth century and includes the Iron Curtain, deserted villages and military monuments. The identification and archaeological mapping of the remains of the Iron Curtain is based on Airborne Laser Scanning data, supplemented by field observation, used to support the documentation of the current status of features and observation of spatial relationships in a wider landscape context. The project is a first step towards cultural heritage protection of monuments from recent history, which are now threatened by development, but are a source of often unique information about this key period in recent history.

Keywords: Cold War, Iron Curtain, landscape archaeology, Czech borderlands, fortifications.

'Cold War' Archaeology

This chapter presents a study of Cold War landscapes in part of the Czech Republic, combining archaeological perspectives with documentary and other sources to explore the historical context and material remains of a defining period in twentieth-century Europe. The added-value of applying non-destructive archaeological methods, including the use of Airborne Laser Scanning data, is demonstrated.

The 'Cold War' period is now receiving increased attention from the social sciences, and also in archaeology where the first of many international projects took place in the 1990s. The earlier ground-breaking projects were conducted in the West and include RAF Greenham Common and the adjacent Peace

Camps in the United Kingdom (Schofield and Anderton 2000: 239–47), the Nevada desert nuclear weapons testing range and nearby Peace Camp in the United States (Beck 2002, Schofield 2005), the anti-air defence of the United States (Whorton 2002) and the remains related to the Cuban missile crisis on Cuba (Burström 2009). A later example is the first mapping of the remains of the Cold War in the former Eastern bloc, mainly using espionage images from CORONA, KH-7 GAMBIT and KH-9, and focusing on the remains of former Soviet air defences, especially the missile bases surrounding Moscow. From image analysis the number of bases, their structure and the supposed equipment they contained and their location in the landscape were reconstructed. All of this research was conducted by international research teams (for example Fowler 2008). The declassified satellite images, combined with air photographs, were also used to study a Soviet radar base near the town of Skrunda in present-day Latvia (Fowler 2010). The 'Berlin Wall', one of the main symbols of the Cold War, has also attracted attention, as a complex monument whose construction started in 1961 eventually extending for 155 kilometres through various modifications over the years (Klausmeier and Schmidt 2006). In the last few years projects exploring 'deeper' research issues of the Berlin Wall have emerged, attempting to document its remains in a broader context (Dolff-Bonekämper 2002).

In the former Eastern bloc, including the Czech Republic, Cold War research is still very young. Recent work by historians on aspects of this period (for example the state-sanctioned execution of opponents, the invasion of Czechoslovakia in 1968 by Warsaw Pact units, military service, emigration and the fall of the Iron Curtain) have begun to appear based on written and other archival sources, or on witness testimonies. Field work and the study of surviving remains are little addressed, even though these sources offer unique information as demonstrated by a few (mostly non-academic) field research projects. The most complex approach so far has been by the Swedish archaeologist Anna McWilliams working on a case study in South Moravia near the border with Austria, which she compared to the Iron Curtain in Slovenia, also considering the archaeological potential (McWilliams 2013). As well as mapping the preserved remains, an excavation of the Iron Curtain was mounted with the aim of determining different building stages (Bureš 2013: 224–6). However, so far no projects have addressed the study of the 'Cold War' landscape as a whole.

Landscape Change in the Tachov Region during the Twentieth Century

The Tachov district lies on the border with Bavaria and is a typical example of a region significantly influenced by the dramatic events of the twentieth century, which have significantly influenced its present form. After 1918 the area became part of the newly formed Czechoslovakia, but this was not welcomed by the local German-speaking population. So, the Munich

Agreement in September 1938 and the transfer of the borderlands (including Tachov) to Germany were generally perceived as positive. Many young men from the area fought in World War II and local businesses, farmers and craftsmen were involved in war production. In the spring of 1945 death marches and transports of concentration camp prisoners passed through the Tachov area and those that died were buried there, although exact locations of burials have often been forgotten. After 1945, the German population was expelled to Germany, followed by an attempt to resettle the region with a Czech population from the hinterland and from abroad. However, the number of settlers from Romania, Ukrainian Volhynia, Poland and other places was not as great as the number of displaced Germans. Thus, while the region had never been wealthy, this period saw a gradual desolation of the region, compounded in 1948 when the border with Bavaria was closed as a result of the Communist coup.

However, the first significant changes in the form of settlement occurred in the Tachov region, as well as in most of western Bohemia, at the end of World War II. In April and May 1945 clashes between retreating Germans and the US military caused damage to a number of small settlements, such as the villages of Bohuslav and Pořejov (Procházka 2011: 77–82, 205). The process of relocating the local German population to internment camps and then to Germany began that same year, while there were also regular uncontrolled border crossings, even of large groups (Hamperl 1996: 38, 158). Resettlement of deserted villages occurred in a disorganised fashion and the results were generally unsuccessful. Secluded and remote settlements in particular were never repopulated and became the repeated target for looters and were later dismantled for construction materials. A complex plan for disposal of abandoned buildings was implemented in summer 1946. Better preserved buildings were intended for public purposes and those in desolate areas or deteriorating conditions were intended as sources of construction material. Since the dismantling and subsequent clean-up was to be done at the new owners' expense the plan attracted very little interest.

A different approach in 1948 focused on the use of buildings and building materials primarily for public purposes (lodgings for seasonal workers, public laundries, cultural centres and so on). The first demolitions of large areas started in July 1950, when all unused buildings not claimed by state organisations (collective farms, state farms, Czechoslovak state forests and so on) were assigned to local national committees, which had the responsibility to remove them (Kovařík 2009: 63–6). This operation, which should have been completed in early August 1951, failed to solve the chronic 'problem' of dilapidated buildings in the border areas. Many of the buildings were only partially removed and their remains subject to further demolitions (Kovařík 2009: 62, Topinka 2005: 570). Therefore, the evaluation of the real impacts of this first stage of demolitions is difficult and with the current state of knowledge practically impossible. However, it is certain that the impact on residential units was limited. A number of cultural monuments (churches, chapels)

were demolished, and in the border areas nearly 2,000 historically valuable monuments, excluding aristocratic residences, were demolished, or proposed for demolition, in 1951 alone (Kovařík 2009: 67).

The second phase of demolition was closely linked to the construction of the Iron Curtain and the creation of a forbidden border zone. After civilians were relocated from the area, the number of unused and dilapidated buildings rose and this reportedly complicated the work of border guards because they might provide hiding places and landmarks for smugglers, foreign agents and refugees (Topinka 2005: 571). So, all buildings (that is including religious buildings, major landmarks and cemeteries) in the border zone that were not used by the border guards or the military were to be demolished. The work was carried out by civilians and volunteers under strict supervision of border guards between 1953 and 1957 (Kovařík 2009: 99–103). However, unexpected organisational and financial problems delayed the schedule and extent of works, with the result that many buildings were not demolished. In 1957 and 1958 there were further demolitions in the restricted border zone, which was a paradox because at the same time buildings were being prepared for a new wave of newcomers. Irreparable and incompletely demolished buildings were scheduled to be removed (Kovařík 2009: 99–114). As before, demolitions were carried out by civilians and volunteers, with 5,631 structures removed, mainly in the Cheb and Aš areas, and to a lesser degree in the Tachov region. Even though this stage was considered a success (due to the number of demolitions and financial costs), it did not solve the problem of dilapidated buildings in the area. The dereliction was disliked by the locals, but also aroused outrage among the displaced Germans, who criticised the state of their former homes in various West German newspapers and magazines. This was a serious political problem to the regime, as it undermined the reputation of the post-war border area transformation. This stimulated further and the most extensive phase of demolitions, which was supposed to deal with this problem quickly, efficiently and finally (Kovařík 2009: 129–30).

The fourth stage of demolitions was organised by the Ministry of the Interior, with local organisations responsible only for listing buildings for demolition. The removal of dilapidated and partly demolished buildings in the areas bordering Western states and along major roads and rail lines was a priority (Kovařík 2009: 124). The volume of submitted applications significantly exceeded expectations and it became painfully clear that this operation would change the face of the border regions forever (Topinka 2005: 571). This phase brought a number of innovations in organisation of work, which was divided between groups of 20 workers, each with its own specialisation. For example the first group removed roofs (tiles), a second took care of beams, rafters and other wooden components, including fittings, while other groups burned or mechanically broke up materials and transported the debris away. The last unit levelled the area with heavy machinery to help it blend in with the surrounding landscape. Although the operation failed to meet designated deadlines, it was considered to be extremely successful.

During its operation between May 1959 and October 1960 this nationwide operation permanently changed the face of thousands of villages and towns, with some of them being completely destroyed. A total of 37,698 structures were demolished in the Tachov region alone, including at least 30 completely destroyed villages (Kovářík 2009: 127–37, Topinka 2005: 571).

These changes in the settlement pattern are also reflected in the wider landscape such as fields and forests. The settlement changes were obviously influenced by land use and natural environment. Unfortunately, today this topic remains on the margins of research interest. There is no detailed research focused on these issues. The landscape settlement has changed also over time: from the relatively strict access to the area of the borderline in the 1950s to the intense economic recovery in 1980s (livestock grazing, forestry work). However, in general, most of the borderland territory was in the long term unsettled and after the Velvet Revolution of 1989, this type of landscape became the seed of many (of today's) nature reserves.

The Iron Curtain

The Iron Curtain became a symbol of the 'Cold War' in Czechoslovakia as well as in other countries, its origins lying in events after the Communist coup of February 1948. The term Iron Curtain symbolises a specific type of construction as well as carrying psychological and social implications. Its origins lie initially in increased security, which included constructing barriers on major border crossings and digging ditches through roads at the smaller ones. On 1 April 1950 the border zone was officially established comprising an area of two to six kilometres, which could be accessed only by the local population. Everyone else had to request a special permit to enter. A forbidden zone was established adjacent to the border and most of the population there was relocated. The Border Guard of selected conscripts was established in 1951 with military status, even though it did not fall under the Ministry of National Defence. Five Border Guard Brigades were eventually formed, further divided into several independent units down to company level. These developments had a big impact on the landscape, which saw buildings and structures destroyed with, on the other hand, increasing numbers of border guards who required many support facilities. This was especially obvious at the company level, where living quarters and other facilities were required near the border. These were built largely by the guards themselves, very often without heavy equipment and machinery (Jílek and Jílková 2006: 22–37).

The border regions continued to change. In June 1951 the forbidden zone was increased to a 2 kilometre wide strip along the border, which was not accessible without a permit and armed escort. The border zone was beyond this zone, and here all inhabitants had to apply for special clearance and even working in the area required a permit. All the local signs (road signs, signposts) were removed, barriers were constructed on local roads and public recreation was prohibited.

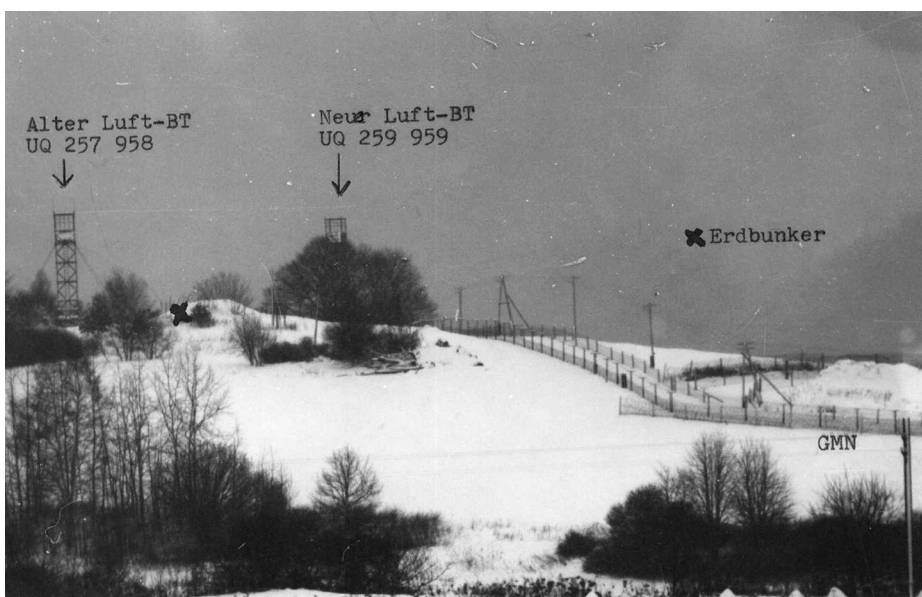
Villages were cleared out from November 1951, shortly followed by the demolition of selected buildings. In the same year it was decided to construct a security barrier near the border – a local version of the Iron Curtain. The first phase consisted of cleared land 20 metres wide, supplemented with a barbed wire fence. In some places, this fence had three rows and selected sections electrified at high voltage and/or supplemented with minefields. The whole system also included watchtowers, roadblocks and barriers on selected routes and a strip of ploughed land, intended to show tracks of possible fugitives. Another security feature was built, from 1956, consisting of a yet another fence, called the ‘signal wall’, made up of wires that short-circuited if touched, identifying the location of the disturbance. The high voltage electric fence and minefields were completely removed by 1965, as they had proved dangerous not only to possible refugees/fugitives, but also to the Border Guard and to wildlife.

A reassessment in the mid-1960s led to a change in the whole concept and rebuilding of the Iron Curtain. The security barrier was moved further inland, a change that should have increased efficiency in capturing refugees still on Czechoslovak soil. The ‘signal wall’ now consisted of a barbed wire fence 2.2 metres high carrying a low voltage electrical current that caused an alarm signal at the local Border Guard station if disturbed. In front of the fence there was a 5–6 metre wide ploughed strip in front of which there was another regular wire fence that stopped wild animals. The border security system now extended to 774 kilometres, with 777 patrol towers (Figure 14.1), reinforced roads for fast moving border patrols, barricades and road obstacles.

But the Iron Curtain was not only ‘wires’ and ‘fences’. This complex barrier and its immediate surroundings were supported by many related buildings and installations, all of which together formed the actual Cold War landscape. These included garrison barracks (Figure 14.2) firing ranges, Czechoslovak People’s Army barracks and other objects, but also the remains of former settlements.

After 1945 preparations for refurbishment of pre-war fortifications were in progress, and assessments were being created from March 1946. In addition, the development of new types of fortifications was under way in the hope of incorporating the knowledge and experience gained in World War II (Dubánek et al. 2008: 13–35). A fundamental shift came in 1950 with the change of the political situation. The original concept of a permanent defensive line was dropped and the Soviet concept of field fortifications was adopted instead. Construction of a new defensive line started in 1952 in connection with the on-going war in Korea, and consisted of field fortifications, complemented with earth mound bunkers and observation posts. In less than two years 400 kilometres of trenches were dug on the western and southern borders of Bohemia, supplemented by more than 2,000 other structures and 85 kilometres of barbed wire barriers (Dubánek et al. 2008: 59–65).

From 1953 the field fortifications were complemented with several types of prefabricated steel-reinforced concrete structures constructed under strict supervision and classification, usually at night. Construction continued until 1964 by which date thousands of structures had been built.



14.1 The landscape as a reference of the Cold War. An example of the Iron Curtain in western Bohemia in 1982. The picture shows the fences, transmitting tower and a precast concrete bunker marked with a black cross. © State District Archive Tachov



14.2 Border Guard barracks in the village of Stara Knizeci Hut photographed in 1985. The members of this crew guarded the area between the deserted villages of Jedlina and Hraničky. Note the fences of the Iron Curtain, running around the barracks. © State District Archive Tachov



14.3 Photogrammetrically documented pillbox. Single-image photogrammetry was processed through 123D Catch. © J. Cibera, L. Starkova

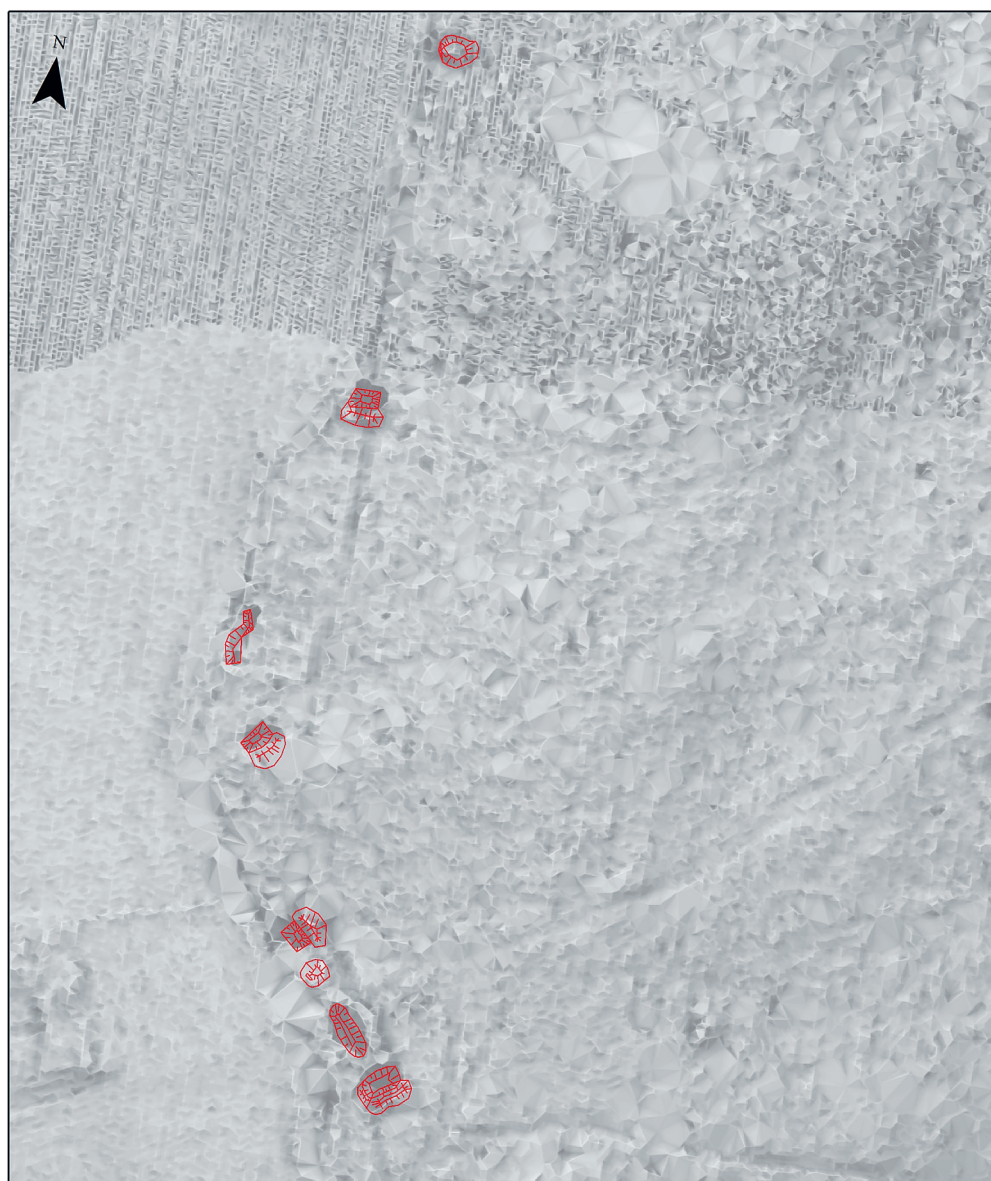
The most common was the prefabricated KŽ-1 pillbox, which was manned by two men armed with a heavy machine-gun and was designed to withstand fire from 57 mm rounds or 82 mm mortars with armour plate for the embrasure and an armoured door (Figure 14.3). This type of pillbox was built up to the 1960s, undergoing only slight modifications since 1945. Other types of bunkers were built in limited numbers in the 1960s, when a wide variety of unarmed structures such as shelters and observation posts were also built. All these structures were built for protection against weapons of mass destruction. (Dubánek et al. 2008: 71–129).

Field fortifications of many different types were the most common structures built along the border, the most common of which were defensive positions for riflemen and machine-gun emplacements sometimes connected by trenches (Figures 14.4, 14.5 and 14.6). Furthermore, there were plenty of defensive fighting positions for a variety of other equipment, including tanks and self-propelled guns, and shelters for various purposes. The processes of construction (including specific dimensions which varied depending on purpose) and deployment can be found in military manuals that were published in large numbers after 1950 and describe the complex functions and strategic purpose of the whole defence system and the individual structures within it. This information provides insights into the types of weapons and numbers of troops that were supposed to be stationed in the area.

From 1955 the same structures were also being built for the Border Guard units. Their line of defence preceded the line held by the units of the Czechoslovak People's Army and their sole purpose was to engage the enemy's primary attack. Border Guard structures can thus be found close to the barbed wire barrier with which it is sometimes interconnected and together they form



14.4 Terrain model from ALS visualised using the Sky-View factor algorithm. Remains of the defensive line, running north-south can be seen in the centre of the image. © J. Cibera, L. Starkova



0 50 100 150 200 Meters

Legend

- Geodetic survey
- Bunker area

14.5 Comparison of visibility and a detailed view of each object of the field fortification line based on ALS combined field mapping using a Leica TS1200 total station. © J. Cibera, L. Starkova



one of the least known parts of the system. During the 40 years of Communist rule in Czechoslovakia, the Iron Curtain proved fatal for almost 1,000 people, not only for those who tried to escape to the West, but also for those who were stationed there (Jílek and Jílková 2006, Tomek 2011: 34–9). The dismantling of the Iron Curtain began immediately after the Velvet Revolution in 1989 and today only a few remnants of the original Iron Curtain remain. Furthermore documentary sources are sketchy and unprocessed, and thus archaeological methods have a great potential for providing new information.

14.6 Shelter for a heavy military vehicle. © L. Funk

Non-destructive Research of the Borderland

Research on the border area of the Czech Republic is entirely new – and due to the fact that it has only recently been opened to the public (and researchers) and is largely unexplored, it is necessary not only to map individual structures, but also to analyse the whole area as a landscape unit. The fact that the area was for long a closed military zone provides a unique opportunity to identify and map a wide range of well-preserved archaeological remains. Mapping and describing the so-called ‘land-use’ of landscape is an integral part of such research (Aston and Rowley 1974, Chapman 2006).

The mapping and interpretation of a wide range of Iron Curtain-associated structures presented challenges that seemed likely to benefit from applying modern methods of landscape prospection. The availability of a wide range

of archival sources supports detailed study of archaeological formation processes and different stages of development. The approach taken was to record a representative sample of structures over a sufficiently large area (Clarke 1977), and in this case Airborne Laser Scanning (ALS) was used, combined with ground observation and verification by non-destructive archaeological methods.

A classified point cloud ALS dataset was purchased. In addition, a range of maps from the 1950s to the present, aerial photographs from the period 1948 to 1958 and contemporary orthophotos were used. Furthermore data from local archives, historical reports, historical photographs, documentaries and oral history were also used.

The foundation of the analysis of this landscape was based on detailed prospecting and mapping of ALS data. Firstly, shaded digital terrain models were output as rasters to provide a basis for mapping, supported by a basic descriptive system. Further visualisation algorithms (for example Sky-View Factor) were applied to increase the potential for detection of the highest possible number of structures. Features were subsequently digitised as vectors and compiled as a plan that, in the next phase, served as the base layer for verification of interpretations. A second phase of field observation focused on verification of interpretations. At the same time, detailed photographic documentation and precise GPS localisation of each structure in the field was carried out. In several cases, the most effective procedure for recording proved to be a combination of ALS data and ground-based total station measurements. This was especially useful where the resolution of the ALS data was insufficient and so failed to capture small or less distinct features. Photogrammetric documentation of selected objects was also included in this stage.

Case Study: The Iron Curtain around Jedlina and Hraničky

The area around the villages of Jedlina and Hraničky provides a case study of the Iron Curtain, elaborating the local context and form of the 'monument', within the wider settlement and historical framework described above. The village of Jedlina (German: Neu Losimthal) was founded in 1637 and by the mid-eighteenth century comprised 34 loosely scattered farms occupied in forestry, woodworking and small-scale local crafts. Further development occurred during the nineteenth century (Procházka 2011: 125–30), and in 1930 it had 392 German-speaking inhabitants in 67 farms. On 24 April 1945 the US Army engaged a small detachment of German soldiers there, and in September 1946, local residents, under the supervision of the National Security Corps, exhumed several corpses from the mass graves of victims of the death marches and these were transported to Tachov. After the expulsion of the German population the village was then partially inhabited for a very short period. The church was used as a watchtower and for hay storage and the

vast hospital complex became a Border Guards station. The first demolitions of unoccupied and dilapidated buildings took place in the early 1950s, with work continuing in the following decades. The church and former hospital were demolished in 1963 although their original location can still be seen in the landscape (Procházka 2011: 130).

Hraničky (Reichenthal) in the area of Nové Domky was founded in 1716, originally comprising a few glass-working plants, joined by hammer mills in 1730. The iron working became dominant, though in 1866–67 glass-cutting and glass-polishing workshops were re-established, which functioned more or less up to 1938 (Procházka 2011: 105). In 1930 the village comprised 325 inhabitants in 51 houses. In 1946 all inhabitants left the village and it has never been repopulated. In 1950 the Border Guard was stationed in some of the original buildings, and these were demolished in 1985 when the troops moved into the newly built Border Guard building in Nové Domky. It was in front of this new building that the ceremonial cutting of the Iron Curtain took place on the 23 December 1989 (Procházka 2011: 106).

The study of the Iron Curtain in a landscape has been difficult because of the lack of a comprehensive cartographic record of its entire course. The ZM10 set of paper maps come closest to such a record and include hand-drawn mapping by border guards, although the accuracy and chronology of individual sections is not guaranteed. However, using modern landscape prospecting methods we have efficiently mapped the probable course of the Iron Curtain in the Jedlina-Hraničky area. Initial interpretations were subsequently examined in the field and compared with historical aerial photographs in the Military Archive in Dobruška and the above mentioned ZM10. Contemporary orthophotos at a scale of 1:5,000 are a very useful source of information, because many forest corridors in the border areas have their origins in the Iron Curtain.

Three lines of ‘fences’ were identified in the study area. The first (and oldest) lies a few metres from the border varying according to the landscape, which here consists mainly of pasture and forest. The pastures are in some places intersected by clearly visible features which could be connected to the placement of pillars supporting barbed wire. Some of these pillars have been reused since 1989 to construct cattle enclosures. These are known from contemporary ground photographs, which also show a characteristic location of nails that held the anti-wildlife fence designed to prevent false alarms (Figure 14.7). Traces of barbed wire can still be found on these pillars. No pillars were found in forest sections of this line, though many ceramic insulators were found instead, indicating that these sections used high voltage fencing, used on the Iron Curtain up to the mid-1960s (Jílek and Jílková 2006: 32–3).

The second line lies about 300 metres back from the first. The first part of this section was in pasture and rather indistinct (Figure 14.8), further confused by a number of other linear features that made it difficult to determine absolutely the proper remains of the Iron Curtain. The mapped lines seem the most likely from the ALS. North of the so-called Güntner Hospital (a former



14.7 Electrical insulators of several types near a rotting pole from the Iron Curtain fence. © L. Funk



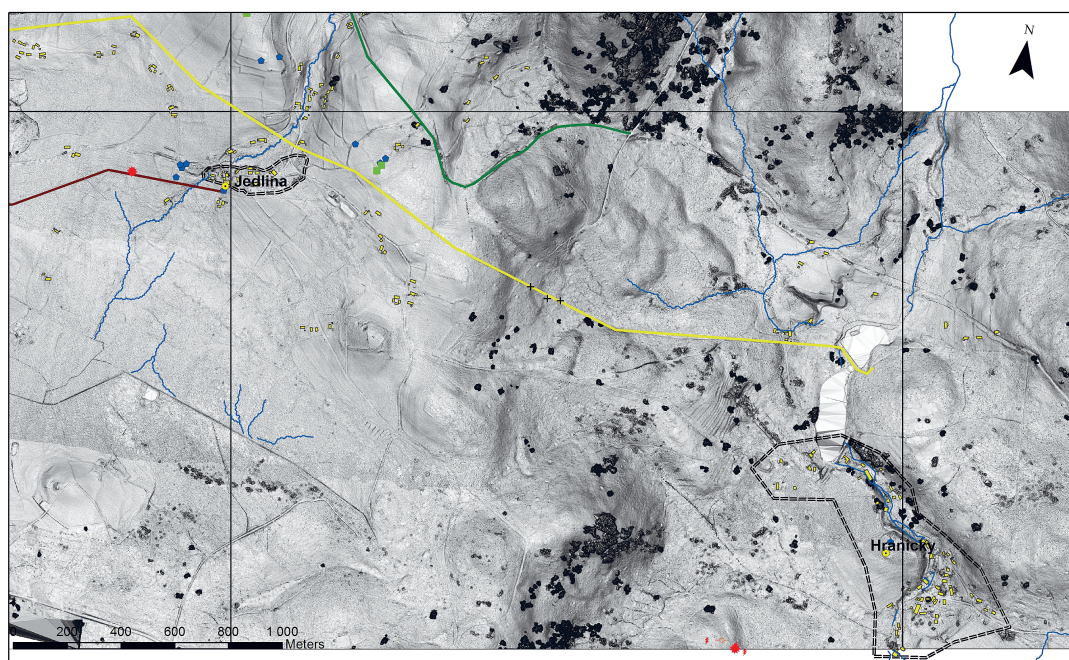
14.8 The fence lines are not clearly visible in the pasture northwest of Jedlina and the reconstruction is based on ALS data. The former presence of the village is preserved today only as a cemetery, which is visible in the centre of the image. © L. Funk



mental institution) it enters the forest, where the line is clearly identifiable as corridors in the trees (Figure 14.9). Concrete pillars are again used for fences outside the forest and inside ceramic electrical insulators can again be found. Deeper in the forest there are several pillars, including one with insulators still attached, and with large rolls of barbed wire nearby. At the dam separating the Upper and Lower Hraniční rybník (pond), the 'wire' was on the dam. The remains of the former village of Hraničky lie at the edge of these ponds. The presence of insulators indicates the fact that this line was built before the mid-1960s, and is assumed to be associated with modifications to border surveillance in the late 1950s (Jílek and Jílková 2006: 32–3).

Around the former village of Jedlina these two lines of 'wires' are accompanied by several field fortifications (Figure 14.10). In the southwest of the village there is a steel concrete machine-gun bunker and a dug out emplacement for heavy equipment, with an infantry trench across the road. On the hill above the village, behind the second line of 'wires', a steel concrete observation bunker has been inserted into the remains of a road, and further away at the edge of a forest there is a further trench and a concrete slab for a watchtower. We assume that these fortifications belonged to the Border Guard. At the top of Kňourek, a hill rising to 729 metres above sea level, to the north of the village there are concrete blocks, which anchored the Czechoslovak People's Army anti-aircraft observation post. Several foxholes and field fortifications from the south and east protect this position. Until its demolition, Jedlina's church tower served as an anti-air observation post.

14.9 North of the deserted village of Jedlina fences enter the forest. At the edge of the forest their presence is still visible due to the naturally seeding vegetation.
© L. Funk



Legend

— Iron curtain in the 70's - 80's	■ concrete foundations	● electrical insulator	● barbed wire	■ deserted buildings
— Iron curtain in the 60's	● bunker	● poles	+ electricity poles	— current water system
— Iron curtain in the 50's	● field fortification	— signaller line		

14.10 The landscape of the 'Cold War' between the deserted villages Jedlina and Hraničky. The plan shows three courses of 'wires', areas with the largest concentration of archaeological artefacts and the object placement of permanent field and defensive systems
© J. Čibera,
L. Starková

Further north of the second line, the third and most recent technical border security line can be found. It is still clearly visible in the landscape and even the red tourist trail follows the Iron Curtain line. Pillars and some rolls of barbed wired are evident, but there were no electrical insulators, suggesting that the line was built after the mid-1960s.

Conclusion

In other countries, especially those in Western Europe, Cold War remains are appreciated as an integral part of national history and are considered in heritage conservation. This is not yet the case in the Czech Republic. The features described above clearly indicate that the border areas are full of remains of this critical period, but even though these are important historical monuments they are not understood as such by the local population and many of them are disappearing without documentation. Forestry operations, especially, endanger the original corridors for the 'wires', field fortifications and other features.

More important is the fact that the features in the Tachov region are not isolated remains, but are linked together spatially and historically. The area was practically inaccessible for 40 years and since 1989 it has been economically

depressed with the result that the landscape has changed little since the mid-1960s. Although most of the structures related to border security have disappeared, the landscape itself remains as a source for research and study that should be undertaken as soon as possible.

References

- Aston, M. and T. Rowley (1974) *Landscape Archaeology: An Introduction to Fieldwork Techniques on Post-Roman Landscapes*. Newton Abbot: David & Charles.
- Beck, C.M. (2002) The Archaeology of Scientific Experiments at a Nuclear Testing Ground. In J. Schofield, W.G. Johnson and C.M. Beck (eds) *Matériel Culture: The Archaeology of 20th Century Conflict*, pp. 65–79. London: Routledge.
- Bureš, M. (2013) Zaniklá kulturní krajina Novohradských hor. Témata, přístupy, metody. In O. Chvojka (ed.) *Archeologická prospekce a nedestruktivní archeologie v Jihočeském kraji, kraji Vysočina, Jihomoravském kraji a v Dolním Rakousku. Sborník z konference, Jindřichův Hradec 6–7 March 2013. Archeologické výzkumy v jižních Čechách – Supplementum 9*, pp. 27–42. České Budějovice: Jihočeské muzeum.
- Burstrom, M. (ed.) (2009) Memories of Word Crisis: The Archaeology of Former Soviet Nuclear Missile Site in Cuba. *Journal of Social Archaeology* 9(3): 295–318.
- Chapman, H. (2006) *Landscape Archaeology and GIS*. Stroud: The History Press.
- Clarke, D.L. (ed.) (1977) *Spatial Archaeology*. London, New York and San Francisco, CA: Academic Press.
- Dolff-Bonekämper, G. (2002) The Berlin Wall: An Archaeological Site in Progress. In J. Schofield, W.G. Johnson and C.M. Beck (eds) *Matériel Culture: The Archaeology of 20th Century Conflict*, pp. 236–48. London: Routledge.
- Dubánek, M., J. Lakosil and P. Minařík (2008) *Utajená obrana železné opony – Československé opevnění 1945–1964*. Praha: Mladá fronta.
- Fowler, M.J. (2008) The Application of Declassified KH-7 GAMBIT Satellite Photographs to Studies of Cold War Material Culture: A Case Study from the Former Soviet Union. *Antiquity* 82(318): 714–31.
- (2010) The Skruna Hen Houses: A Case Study in Cold War Satellite Archaeology. In D.C. Cowley, R.A. Standring and M.J. Abicht (eds) *Landscapes Through the Lens: Aerial Photographs and Historical Environment*. Occasional Publication of the Aerial Archaeology Research Group No. 2, pp. 287–93. Oxford: Oxbow Books.
- Hamperl, W.D. (1996) *Vertreibung und Flucht aus dem Kreis Tachau im Egerland 1945–1948*. Trostberg: published by the author.
- Jílek, T. and A. Jílková, A. (eds) (2006) *Železná opona: československá státní hranice od Jáchymova po Bratislavu v letech 1948–1989*. Praha: Baset.
- Klausmeier, A. and L. Schmidt (2006) Commemorating the Uncomfortable. In J. Schofield (ed.) *Re-mapping the Field: New Approaches in Conflict Archaeology*, pp. 22–7. Berlin/Bonn: Westkreuz-Verlag.
- Kovářík, D. (2009) *Demoliční akce v českém pohraničí v letech 1945–1960*. Unpublished thesis. Brno: Masarykova univerzita.

- McWilliams, A. (2013) *An Archaeology of the Iron Curtain: Material and Metaphor*. Huddinge: Södertörns.
- Procházka, Z. (2011) *Putování po zaniklých místech Českého lesa. II., Tachovsko: osudy 45 zaniklých obcí, vsí a samot*. Domažlice: Nakladatelství Českého lesa.
- Schofield, J. (2005) *Combat Archaeology: Material Culture and Modern Conflict*. London: Duckworth.
- Schofield, J. and M. Anderton (2000) The Queer Archaeology of Green Gate: Interpreting Contested Space at Greenham Common Airbase. *World Archaeology* 32(3): 236–51.
- Tomek, P. (2011) Ochrana státní hranice a Pohraniční stráž. *Historie a vojensví* 60(3): 26–39.
- Topinka, J. (2005) Zapomenutý kraj. České pohraničí 1948–1960 a takzvaná akce dosídlení. *Soudobé dějiny* 12(3–4): 534–85.
- Whorton, M. (2002) Evaluating and Managing Cold War Era Historic Properties: The Cultural Significance of US Air Force Defensive Radar Systems. In J. Schofield, W.G. Johnson and C.M. Beck (eds) *Matériel Culture: The Archaeology of 20th Century Conflict*, pp. 216–26. London: Routledge.

‘Anzac from the Air’: Re-imagining the Australian War Memorial’s Gallipoli Aerial Collection

Luke Diggins, Kate Morschel and Snow

Abstract

‘Anzac from the Air’ is a focal interactive display within ‘Australia in the Great War’, the Australian War Memorial’s new permanent exhibition commemorating the centenary of World War I. This large-scale touch screen comprises a series of aerial reconnaissance photographs of the Gallipoli peninsula in 1915 that have been stitched over a digital topographical model of the terrain as it appears today. ‘Anzac from the Air’ aims to enhance visitor understanding of the Anzac campaign through user interaction. Incorporating common gestures that are familiar to tablet and smartphone users, such as pinch, zoom, rotate, tilt and pan, visitors can navigate the virtual landscape to explore key locations and events of the campaign. This chapter illuminates the curatorial, conceptual and technical development of ‘Anzac from the Air’. In so doing, the authors illustrate the complexities and discoveries behind re-imagining a significant photographic archive as a major museum digital experience.

Keywords: Gallipoli, Royal Naval Air Service, museum, World War I, digital display, centenary.

Introduction

As the nation’s leading war memorial, museum and military history archive, the Australian War Memorial plays a central role in commemorating and interpreting the nation’s experience of World War I. In anticipation and recognition of the centenary of this epochal conflict the Memorial has undertaken a major redevelopment of its World War I galleries. One of the key features of this new permanent exhibition, ‘Australia in the Great War’, is the interactive touch wall ‘Anzac from the Air’.

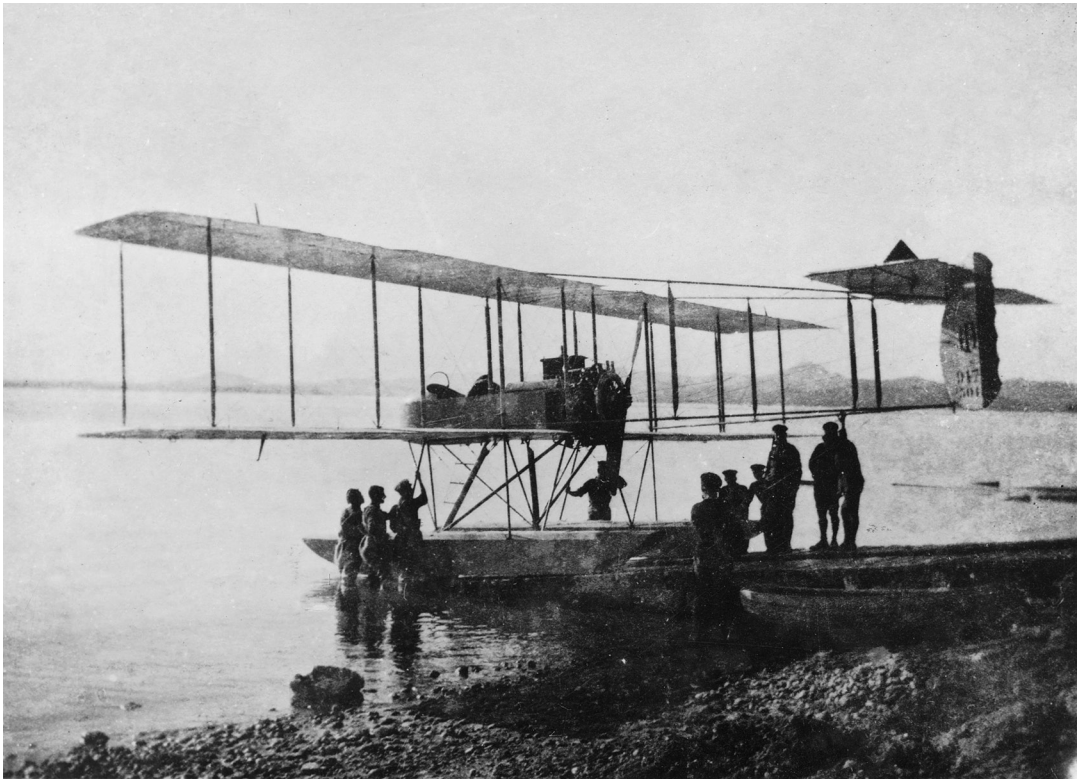
This large-scale display of aerial reconnaissance photographs, taken above the Gallipoli peninsula in 1915, enables visitors to explore the topography which served as a backdrop to the ill-fated Anzac campaign (see also [Chapters 16 and 17](#) for other applications focusing on the Western Front in Belgium and the Isonzo theatre of war in Italy). Drawing upon the Memorial's archival collections, 'Anzac from the Air' combines historical aerial photographs with current geo-spatial, three-dimensional data of the peninsula. In this significant museum experience, the leading-edge military technology of 1915 is reimaged in the digital age of 2015.

The formation of the Memorial's collection of aerial photographs dates from the 1920s, when they were used for historical research – notably by Australia's official war historian C.E.W. Bean. This archive was re-interpreted as a digital experience by the exhibition's curators and digital partners in 'Anzac from the Air'. Beginning with the concept development phase and moving into the final information architecture and interaction design, this chapter discusses the challenges faced, and the revelations uncovered, in creating this unique display.

Aerial Photographs of Gallipoli

The Australians' Gallipoli campaign lasted from April to December 1915. At this time aerial photography was still in its infancy. The first aerial photographs of the peninsula were taken by men of the Royal Naval Air Service (RNAS), flying primitive aircraft such as the Sopwith Tabloid and the Short 225 seaplane from bases on the nearby island of Tenedos, or from the seaplane carrier HMS Ark Royal (Hart 2000: 1) ([Figure 15.1](#)). Initially, these reconnaissance missions required pilots to fly low over enemy positions while images were obtained by an observer holding a rudimentary camera over the side of the aircraft. The advance of anti-aircraft defences resulted in pilots having to fly higher to avoid enemy fire. This led in turn to the use of cameras with greater focal lengths and more powerful lenses (Rutherford 2005).

Technical developments in aerial photography were primarily driven by the conflict on the Western Front, and by the summer of 1915 some notable advances had been made. Cameras, previously hand-held, had begun to be fixed to the side of the aircraft. And where earlier cameras required the observer to manually change glass plates – a tricky proposition while flying in an open cockpit – a semi-automatic magazine system soon superseded this. Furthermore, this system, which was activated by a lever controlled by the observer, allowed multiple photographs to be taken in a short amount of time (Finnegan 2011: 268–9). The spread of such developments to the Gallipoli theatre generally lagged behind other areas, or did not happen at all. As a result, it is not known when (or indeed whether) these developments were implemented by British airmen at Gallipoli; however, the photographs taken by Flight Lieutenant



C.H. Butler, which form the majority of the Memorial's holdings in this area, are believed to have been taken by hand (Rutherford 2005).

In addition, the interpretation of aerial photographs by commanders on the ground was also relatively novel in 1915. While the photographs generally enabled British commanders to analyse Turkish movements and dispositions, the failure to identify Turkish trenches covered in heavy pine logs prior to the attack on Lone Pine, for example, testifies to the still-experimental nature of the technology (Clark 2005: 28). Nevertheless, the photographs provided previously unobtainable yet immensely valuable topographic data of the peninsula. Indeed, what can be seen in the surviving photographs (which were used in 'Anzac from the Air') is the changing nature of the Gallipoli landscape as the trench systems expanded and became more complex and as support bases and lines developed. And the combination of the Gallipoli aerial shots with the undulating landscape of the terrain model means visitors can now see and understand why the Turkish and Anzac trenches were situated where they were.

15.1 A Henri Farman F.27 floatplane of the RNAS at a launching ramp after completing a patrol over the Gallipoli peninsula. Source AWM P03309.002

ORIGINS OF THE COLLECTION

The Memorial's World War I collection owes its origins to the establishment, in May 1917, of the Australian War Records Section (AWRS) (Figure 15.2).



15.2 Staff of the War Diaries Subsection transcribing records at the London headquarters of the Australian War Records Section. Source AWM D00627

The AWRS assumed responsibility for the Australian records from the British War Office and spent the remainder of the war commissioning and collecting relevant paper records, relics, photographs, film, publications and works of art. In 1919 the collection was brought back to Australia, forming the basis of the Australian War Museum (later Memorial) in Melbourne (Anderson 2012: 41–2).

It is assumed that the aerial photographs of Gallipoli held by the Memorial – 166 of the estimated 700 taken by Flight Lieutenant C.H. Butler and later Flight Lieutenant Thomson of No. 3 Squadron, RNAS (King 2001: 4, Samson 1930: 227) – were acquired during the 1920s and 1930s to assist in the writing of the Australian official histories (AWM93). The Memorial's holdings are currently the largest-known controlled collection of Gallipoli aerial photographs from World War I, the Royal Air Force's original reconnaissance negatives having been destroyed in the 1950s. A combination of derivative prints and glass copy negatives, the Memorial's photographs are more significant still, having survived severe deterioration and fading since their copying by the AWRS in the 1920s (AWM16). The photographs, now split across three collecting areas, are the subject of ongoing research to establish the original source and uncover comparative holdings.

The World War I galleries' redevelopment 'Australia in the Great War' sees the widespread introduction of digital interactive and interpretative displays at the Memorial (Figure 15.3). The curatorial development of these displays



has been driven by significant shifts in visitor behaviour and expectations, noticeably so since the last refurbishment of World War I galleries in the early 1970s. Visitor research conducted as part of the recent redevelopment indicated an expectation of interactive and interpretive digital technologies in the exhibition (Colmar Brunton 2013). The general understanding taken from this research suggests that contemporary visitors seek self-driven discovery and exploration, and are accustomed to accessing information using touch screens.

'Anzac from the Air', along with the exhibition's other digital elements, reflects the shift in understanding of curating for visitor experience. Working closely with the Memorial's digital partners, Holly – a digital agency based in Sydney – 'Anzac from the Air' uses the latest touch-screen technology to enable visitors to drive their own interpretative experience. As context, the Memorial's outmoded World War I galleries – which for 40 years had remained largely untouched – reflected earlier museum practices in which visitors were cast as passive observers rather than active participants.

15.3 A view of the newly redeveloped World War I galleries showing the entrance and Ascot Boat, an iconic relic from the Anzac landing. Source AWM PAIU2014/252.16

THE CONCEPT

Terrain played a critical role in shaping the course and outcome of the Gallipoli campaign. During the landings on 25 April 1915 the rugged ground proved as great an obstacle as the Turkish defences. The Allies faced a similar struggle during the August Offensive and the failed attempts to capture the commanding heights of the Sari Bair range. The landscape has also played a role in feeding the Anzac legend, as Ashley Ekins, the Memorial's Head

of Military History, explains: 'The campaign's enduring fascination and romantic appeal derives in large part from its dramatic natural setting' (Ekins 2013: 77).

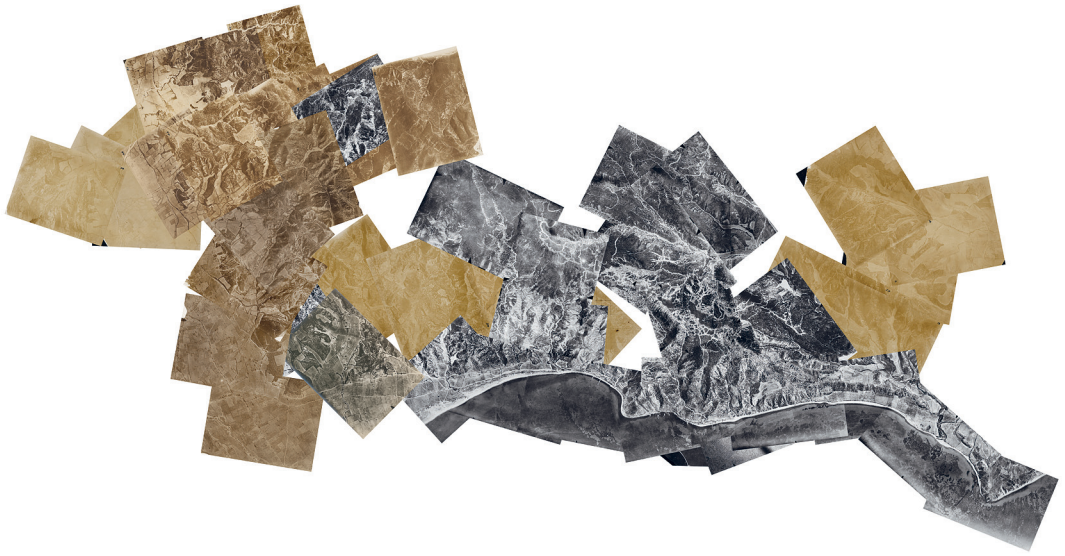
The terrain and its influence on the course of the Gallipoli campaign had been explored in the former galleries through two interpretative models. Design constraints meant that these would no longer be displayed, leaving a substantial gap in the Gallipoli story. The aerial photographs presented an opportunity to address the limitations imposed by terrain on the Allied operations on Gallipoli and to use the historic collection in a new way by combining it with digital technology to explore the battlefields while identifying positions such as Lone Pine, the Nek and Quinn's Post. It also enabled the Memorial to introduce the story of aerial operations on Gallipoli, an often-overlooked aspect of the campaign, and to explore one of the earliest uses of aerial photographs in the war.

This was achieved by incorporating interactive points of interest on the completed mosaic. These points of interest, when activated, reveal additional information and collection content about the position, event or action. For example, the landing on 25 April is illustrated through graphic markers showing both the intended and the actual landing position. Other points of interest identify cemetery positions, the Turkish counter-offensive of 19 May, and the movement of Australian and New Zealand troops in the August attacks at Lone Pine, the Nek and Chunuk Bair.

COLLECTION CHALLENGES

Creating the mosaic presented the Memorial team with significant challenges. An intensive survey of the collection was conducted as part of the development process; derivative prints and negatives were compared to determine which images provided the most complete coverage of the peninsula and which would best translate to large-scale display without significant loss of image quality. The photographs form an incomplete record of the Australian and New Zealand positions, with data missing from critical areas inland from Anzac Cove. Furthermore, the photographs were taken months apart. Though useful for exploring changes in specific positions, the construction of the mosaic resulted in significant overlaps, with trench lines and formations often disappearing between photographs. Although several photo-mosaics were published after the war, the one intended for display was a modern-day production (Figure 15.4), and it was important that the photographs be recognised as discrete objects.

In addition, the quality of the photographs was found to vary. The early reconnaissance methods and equipment used on Gallipoli made the images susceptible to distortion and displacement caused by sudden movement, changing altitude and vibrations from the primitive aircraft. Post-production work compensated for some of these variables, but it was critical that the final mosaic accurately represented the Memorial's collection holdings.



CONCEPT DESIGN

Various applications have developed and popularised the virtual globe in computing, including the Microsoft Encarta Virtual Globe (1999), Google Maps (2003) and Google Earth (2005.) The visual and gestural languages used to describe and control virtual landscapes have developed with the increasing use of these applications on mobile devices. These include having 'full tilt', 'pan' and 'zoom' control of the landscape, filtered points of interest and the common language of flags and labels. 'Anzac from the Air' incorporates many of these common user interfaces and gestures. This approach means 'Anzac from the Air' not only provides a digital way of interpreting historical landscapes, but is also designed to be intuitive and accessible.

From an interface design perspective 'Anzac from the Air' references the circular and orb shapes of photographic lenses, compasses and gyroscope gimbals (Figures 15.5 and 15.6). Primary control is provided by the master controller – a familiar and easy-to-use interface element that moves and zooms the image. The master controller also doubles as a seamless control system for group presentations by guides.

Ensuring 'Anzac from the Air' can accommodate multiple users at a time, the map can generate up to three more iterations of the controller known as 'mini-verses'. These subordinate control interfaces display a smaller Gallipoli terrain map, while the main control of the large map is retained by a single person. The mini-verses and main controller can be dragged around the screen to accommodate different accessibility requirements.

15.4 The combined aerial mosaic stitched together by the Memorial's Multimedia section during concept testing. Source AWM P11489.001



15.5 Staff demonstrating points of interest and information boxes in 'Anzac from the Air'. Designed and developed at Holly, Sydney. Includes material © CNES 2014, Distribution Astrium Services / SPOT image S.A., France. Source AWM PAIU2015/003.001

TECHNICAL DELIVERY

Another challenge of the project was working with the combined aerial mosaic. On one hand, the objective was to retain the integrity of the original images; on the other hand, there were visual gaps between some images and image displacement in others. To compensate, and to afford an understanding of the strategic implications of the landscape, a terrain model was used to clue users into the actual landscape and the missing landscape information. This was done by layering the aerial mosaic onto a model of the contemporary terrain.

The terrain model was built by Airbus using CNES satellite data. Here multiple images taken from different points are combined to generate a stereo image. 'Anzac from the Air' uses a two-metre resolution terrain model to produce a highly accurate wireframe of the Gallipoli peninsula and its topographical features. The mosaic of aerial photographs is then layered over



the topographical data, intentionally leaving a wireframe where the image is absent. Outside the border of the aerial mosaic is an interpretive landscape fill.

Key to the functionality is the ability to zoom in and out so the user can occupy different viewpoints and explore elements of the terrain. Performing this zoom action within a high-resolution model displayed on high-resolution screens proved a technical challenge. To do this effectively the software dynamically and responsively lowers or increases the level of detail the visitors see as they manipulate the landscape. As the user adjusts the magnification, the level of detail, which is determined by the total polygon count, increases or decreases in accordance with the direction of the zoom.

This problem is not new to museums, and to ensure the best visual experience technically possible Holly took advantage of cutting-edge advancements in gaming graphics programming that draws on the processing power of graphics cards. Displayed from three linked computers across nine large touch screens, 'Anzac from the Air' offers an extremely high-resolution visual encounter on a human scale. The end result is a visitor experience that offers a new way for visitors to engage and interact with the landscape, and to appreciate the crucial role it played during the Gallipoli campaign.

Initial visitor surveys, conducted during the opening in December 2014, have shown 'Anzac from the Air' to be one of the most popular interactive displays in the galleries. Visitors have described the touch screen as 'impressive', 'amazing technology' and a 'fantastic inclusion' (AWM 2014). However, some visitors have found the technology unfamiliar and the scale of the display intimidating.

15.6 A detailed view of 'Anzac from the Air' showing the primary navigation interface. Designed and developed at Holly, Sydney. Includes material © CNES 2014, Distribution Astrium Services / SPOT image S.A., France. Source Lucy Parakhina, 2014

Visitor feedback on the content has been inconclusive. When asked what visitors thought the map was showing responses have varied from 'something to do with Gallipoli' to 'aerial photography of Gallipoli area and the broader geographical context' (AWM 2014). Although information about the aerial photographs has been included, these responses suggest that the collection is being lost in the experience. These issues will be addressed in an updated version of the display to be installed late February.

Conclusion

'Anzac from the Air' is a key display in the Memorial's recently refurbished World War I galleries, and it offers a unique view of the Gallipoli campaign. Featuring the Memorial's collection of aerial reconnaissance photographs of the Gallipoli peninsula, the touch screen allows visitors to explore the landscape as it appeared in 1915, and to interrogate the campaign using a familiar interface and suite of gestures.

Although the collection posed significant challenges, the final display has successfully brought technology from 100 years ago together with cutting-edge interactive display techniques of today. This interpretation represented a dramatic shift in the Memorial's approach to the collection and exhibition development and will undoubtedly encourage similar innovations in the future.

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References

- Anderson, N. (2012) *Australian War Memorial: Treasures from a Century of Collecting*. Millers Point, NSW: Murdoch Books.
- AWM93 = Australian War Memorial registry file: Photographs (Air) Lent for reproduction Vol. 2 by Lt. Col. C.H. Butler, Negs forwarded to AWM. AWM93 17/3/26.
- AWM16 = Australian War Records Section registry files and register of file titles: Maps, relief maps and air photos [includes report on the work of maps and air photos (2 AWC) War Records Section, and a list of war maps required by the Australian Government for inclusion in historical records]. AWM16 5.

- AWM 2014 = Australian War Memorial (2014) *Australia in the Great War Remedial Evaluation*. Unpublished survey.
- Clark, C. (2005) Air War over Gallipoli. *Wartime* 30: 27–9.
- Colmar Brunton (2013) *Australian War Memorial Audience Evaluation*. Unpublished survey.
- Ekins, A. (2013) A Ridge Too Far: The Obstacles to Allied Victory. In A. Ekins (ed.) *Gallipoli: A Ridge Too Far*, pp. 76–103. Wollombi, NSW: Exisle Publishing.
- Finnegan, T. (2011) *Shooting the Front: Allied Aerial Reconnaissance in the First World War*. Stroud: Spellmount.
- Hart, P. (2000) *Gallipoli: The Air War*. http://archive.iwm.org.uk/upload/package/2/gallipoli/pdf_files/GallipoliAirWar.pdf (retrieved 20 January 2015).
- King, B. (2001) *Gallipoli: The Royal Naval Air Service and the Dardanelles*. http://archive.iwm.org.uk/upload/package/2/gallipoli/pdf_files/RNAS%20Dardanelles.pdf (retrieved 20 January 2015).
- Rutherford, D. (2005) *Guide to the Gallipoli Aerial Photographs*. <http://www.awm.gov.au/findingaids/guide-gallipoli-aerial-photographs-collection/> (retrieved 20 January 2015).
- Samson, C.R. (1930) *Fights and Flights*. England: Ernest Benn.



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Italian World War I Aerial Photographs for Landscape Study and Public Engagement

Roberta Cuttini

Abstract

The Italian military was an early adopter of aerial photography for intelligence purposes, and images taken during World War I of the Austrian-Hungarian front are a valuable source for understanding this complex conflict landscape. This chapter focuses on the development of Italian aerial photography during this period with particular reference to the growing importance of camouflage techniques to conceal installations and other features from airborne observation. Furthermore, the value of such imagery of the front and other areas in Italy and Slovenia to create contemporary user engagement with the century-old conflict through digital media developed from the World War I aerial photographs is discussed.

Keywords: World War I, Italy, museum application, historical landscape, aerial photography, military landscape.

Introduction

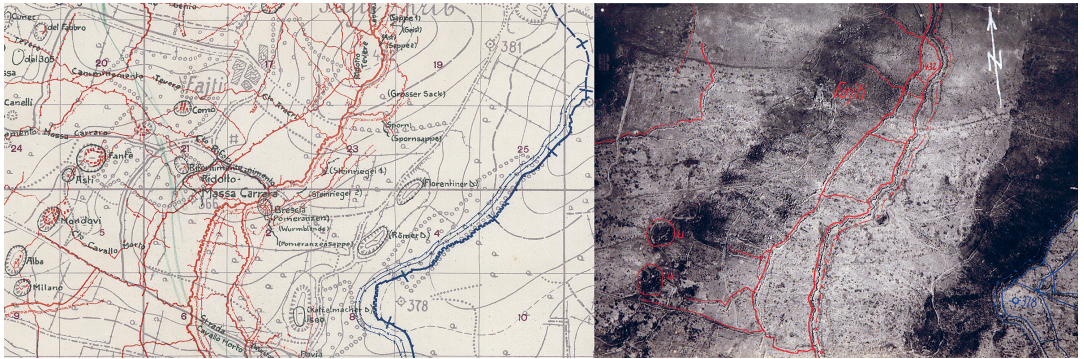
This chapter has three parts, the first of which reviews the military application of aerial photography during World War I, principally in an Italian and Austrian-Hungarian (Karst) context. The second section deals with landscape camouflage techniques designed to obscure military features from aerial observation. The third part reports on a collaborative project that creates a digital engagement with the landscapes of World War I, and a source for a variety of landscape studies and planning.

16.1 Aerial view of the city of Udine. Courtesy Fototeca Vigna di Valle



The Development of Italian Military Aerial Photography in World War I

In trench warfare aerial photography developed as a tool of primary importance not only for providing a view of enemy dispositions, but also for controlling artillery fire. While the French Army was the first to introduce aerial photography for military intelligence using hot-air balloons, the Italian Army established its own Air Section at the end of 1884 (Chiusano and Saporiti 1998, Di Martino 1999: 7, Di Martino 2011: 26, Lodi 1976: 37, Tardivo 1911, Zicavo 1928). In 1911 and 1912 during the war with Turkey over Libya, Italy was first to make effective use of dirigibles and aircraft for reconnaissance (Di Martino 2011: 23, 587, Porro 1936: 22). On 1 April 1915 the Italian Army, strengthened by its experience on the Western Front, established the Gruppo Squadriglie Aviatori per l'Artiglieria, tasked with reconnaissance and fire control, heralding what would become the most important use of airplanes (Di Martino 2011: 50). Direct observation of the ground, common in the period 1915–17, when the front between Italy and Austria-Hungary was on the Karst, means that relatively few aerial photographs were taken (Figures 16.1 and 16.2). However, ground observation was soon integrated with ever more extensive photographic survey, with dense coverage of the Piave frontline. Here from 1918 aerial photographic reconnaissance by opposing armies was systematic. There are thousands of images of this date in the Kriegsarchiv in Vienna including several series of photographic sorties taken every two weeks by Austro-Hungarian reconnaissance aircraft. Intelligence from photographs and direct observation from the air were cross-checked with other sources of information, such as questioning of prisoners, telephone tapping, captured documents and landscape reconnaissance. Methods of aerial survey and the



translation of that information on to maps were gradually refined. From July 1915 the Italian Army adopted 1:25,000 scale maps, which were already used by the Austrian-Hungarian Army, marked with a 1 kilometre square grid on to which the results of reconnaissance were noted (examples are held in the Archivio di Stato of Florence and in the Kriegsarchiv in Vienna).

The airborne view, whether from aircraft or air balloon, varying from vertical and oblique images, benefited from the gradual perfection of the use of automatic and sequential cameras (Di Martino 1999: 277). Alongside camera developments the interpretation of aerial photographs improved during the war due to training courses and manuals drawing on a broad range of images (AUSSME: photo albums 10, 11, 12). It was soon recognised that while aerial photographs taken at an appropriate height and under favourable lighting conditions convey a good impression of landscape topography, tricks of light and shadow can obscure the real form of the ground. Here the use of the stereoscope was important, exaggerating elevations and highlighting the height of features with a small base and outstanding height, like isolated trees or bell towers, which might otherwise be difficult to interpret on vertical aerial photographs (Di Martino 2011: 23, 587, Porro 1936: 22).

The potential and challenges of interpreting aerial photographs faced during World War I are also there for present-day users of the imagery, who require deep knowledge of the terrain and the types of features that may be present. Sequences of images allow the modifications of defensive systems in the face of Italian offences to be studied, for example in the development of trench systems from straight to sinuous and then to geometric zigzags, and in the variety of forms. The same principles apply to the interpretation of road and railway lines.

Karst landscapes present particular difficulties of interpretation, as white exposed rocks alternate with patches of red soil and dark patches of woodland, further complicated by extensive dolines (sinkholes) and fissures within areas of *karren* or *lapiez* (that is limestone pavement). The natural landforms offered military advantages, as dolines can provide shelter (see also [Chapter 9](#)). Shadows are important for the interpretation of buildings, and on the Karst plateau they are vital to the identification of shelters in caves whose entrances

16.2 Trench lines on the Fajti – Karst. Comparison of map and photo. Source author

are recorded on aerial photographs as small black rectangles with adjacent white excavation spoil heaps.

Interpreting the defensive systems of the farmed flat area around the Piave River is much easier, even though great care is needed when interpreting the shadows.

The Development of Landscape Camouflage and Deception Techniques

The growing use of aerial intelligence prompted the development of camouflage and deception techniques, beginning in spring 1917 (del Genio 1917). These included the construction of decoy landscapes with fake buildings, shadow effects and different camouflage patterns and schemes to puzzle the enemy.

Initially painted wood and wickerwork and rudimentary stained canvases were used for camouflage, but the need to put the supply of effective camouflaged fabric on a systematic larger-scale footing was soon clear. In spring 1917 the Italians drew on French experience in manufacturing, assembling and using camouflage to hide buildings and equipment from Austro-Hungarian reconnaissance aircrafts. Then General Maglietta Luigi Knight, Defence Force Commander in Chief, established a Camouflage Commission to assess requirements according to the nature of the frontline, the needs of troops and the supplies available, with experimental facilities at Lacenigo, close to Treviso and Carpi amongst others (del Genio 1919). The Carpenedo laboratory specialised in matching the terrain and vegetation around Cavallino, Taglio del Sile and Basso Piave, while the S. Artemio laboratory produced arbours, vineyards, corn and sweetcorn fields camouflage (del Genio 1919).

Due to a shortage of raw materials camouflage nets were produced using hemp yarn instead of the 'raphia' used by the French (del Genio 1919). The nets were embellished with plant material to simulate various ground conditions, and in time cuttings of poplar or willow produced in Carpi were tested to make straw hats. Camouflage intended to simulate rocks employed pieces of jute cloth painted using encaustic techniques by set designers and painters, like Antonio Discovolo, which improved the stability of basic dyes and introduced complementary colours. The ways of attaching willow to nets was also studied, as a common knot gave a flat appearance to the net that is easy to recognise on photographs. Special attention was given to methods of staining and layering the nets to represent realistic landscapes. For example, a net resembling gravel was developed to conceal buildings on riverbeds by knotting together small shreds partly white, partly dyed red, yellow and grey.

The art of disguise was taught by an increasing knowledge of 'camouflage' (disguise of objects), 'maquillage' (breaking up objects – little used by Italian troops), 'mimesis' (disguising objects as something else, setting), of artifices to imitate colours (mimetic nets) or to eliminate light and shading effects (sloping surfaces, concealments, shadings). Such training included study of natural,



artificial and mixed methods of concealment as well as fake works and concealment strategies, and was integrated by examination of aerial photographs. Camouflage strategy was planned in every detail taking into account sketches of works and battle arrays provided by Engineer and Artillery Commands and aerial photographs taken before, during and after works at lower altitude than those possible over enemy ground. A process of review was implemented to assess concealment works on the ground. At first, attention was focused on the concealment of gun batteries, but camouflage with road festoons of groups of vehicles and ammunition and equipment storage depots was also extensively used.

In order to hide distinctive features like trucks, containers and boats camouflage aimed to remove shadows or to alter their shape and shadows (Figure 16.3). The alignment of barracks and repetition of elements clearly identifiable as military targets were avoided and buildings were concealed with coloured reed wattles imitating shingles or with festoons, while fake chimneys and other details might be added in order to make the building look like an agricultural or domestic structure, including modifying the surroundings as well (Figure 16.4), taking account of the regular lines of the farming system (del Genio 1919).

Camouflage was set up as a special service only as of April 1918 with the circular n. 40,316 dated 7 April 1918 issued by the Technical Office of the High Command. The relevance of camouflage led the inter Allied Command to organise on 20 August 1918 a technical conference with the representatives in charge of the camouflage of the French, English, American, Belgian and Italian armies. An Italian officer (Lieutenant Discovolo) was nominated as representative of the Italian Army at the Camouflage Laboratory of the French Camouflage Chief of Staff.

16.3 Hay barn camouflage of a gun emplacement. Courtesy ISCAG



16.4
Camouflaged
road.
Courtesy ISCAG

However, despite these extensive efforts the expert observer soon becomes adept at reading deceits, for example in identifying the positions of hidden artillery from the white line left on the ground at the firing of the gun, the so-called 'blast marks'.

Contemporary Engagement with the Historical Landscape of World War I

It will be clear from the discussion above that the legacy of aerial photographs from World War I in Italy offers considerable information for the study of the conflict landscape and its exploration by communities that are now removed from the conflict by a century. An aerial perspective of the World War I battlefields on the Italian Eastern Front is the focus of the Interreg Italy–Slovenia project 'ALISTO – Wings on History'. This cross-border project draws on the synergy between historical research and technological development in flight simulator software to explore the historic-architectural-scenic heritage. The project recreates the historical cross-border landscape with Italian and Austrian-Hungarian World War I aerial photographs and allows comparison of the 1915–18 landscape and the present one, with digital orthophotos illustrating both continuity and transformations (Figure 16.5, see also Chapters 15 and 17).

The first stages of the project comprised extensive research on the Italian and Austrian-Hungarian military and non-military archives by experts in history and landscape (the author and Mr Mauro Scroccaro were commissioned by Marco Polo System EEIG – European Economic Interest Grouping)



to study the historical territory. This created a thematic database of the historical aerial photographs, mostly unpublished, for the Friuli Venezia Giulia and Veneto (Province of Venice and Treviso) regions, the Province of Ravenna and Slovenia. It is the first systematic research of this kind executed both in Italy and Austria-Hungary. Almost 3,000 aerial photographs of the Italian–Austrian-Hungarian frontline of World War I have been digitised and analysed. The evidence of the aerial images was combined with historical maps to allow the reconstruction of the military infrastructure in the different phases of the conflict, including camouflaged or faked structures.

16.5 Grado, comparison of World War I aerial photograph and contemporary orthophoto. Source author and courtesy LP and the Autonomous Region of Friuli Venezia Giulia

The historical-archive research provides a view of the landscape at a particular historic moment, before the extensive transformations of the twentieth century caused by demographic growth, expansion of cities, industrialisation and reconstructions following natural calamities (for instance earthquakes at Friuli in 1928 and 1976, floods).

These transformations in parts of the studied area (Veneto and Friuli) have radically modified both the form of the landscape, but also the perception of it by inhabitants. Landscapes have been modified through the transformation of the coastline by riverine processes and human activity, including the construction at the end of the nineteenth century of breakwater dams at the port entrances of the Venice lagoon, land reclamation during the twentieth century and the major urban development from the 1970s, that has particularly affected the Veneto region (Cuttini and Scroccaro 2014).

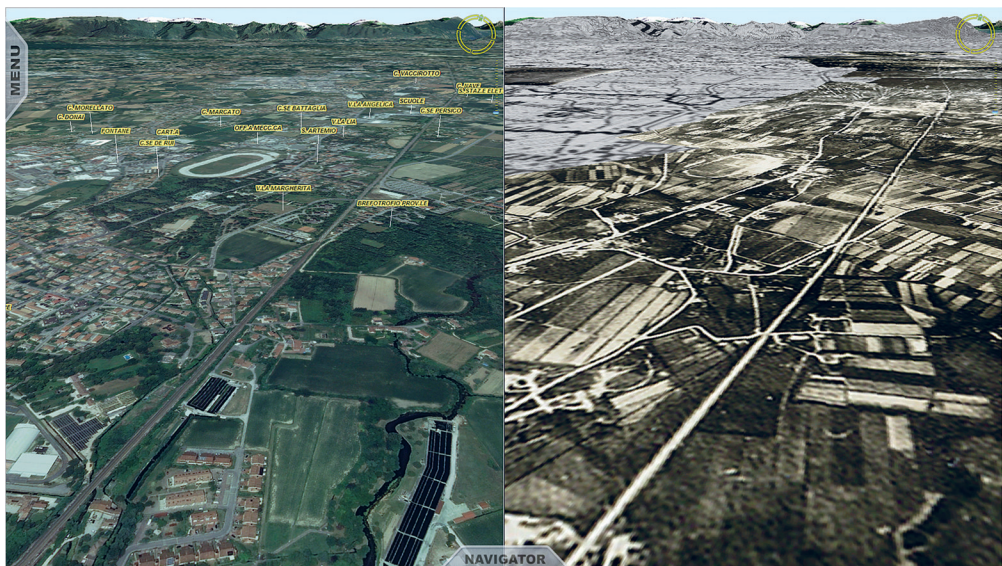
Here lies the importance of the systematic use for the first time of the World War I aerial photographs as evidence for the study of landscape transformations, not only in historic-military contexts, but also in a historic-landscape-sociologic one. The mosaic of almost 3,000 aerial photographs enables the reading of the impact of the war on the landscape. The huge excavation works for fortifications and infrastructure of the area, with the building of bridges, roads, railway tracks, airfields and other military installations modified the spatial relations between places and introduced elements that in time became characteristics of the landscape in an ongoing diachronic process of transformation. Some remains have survived, others have been removed, and the comparison with contemporary satellite imagery allows the examination of the transformations of the natural and anthropogenic landscape.

The historical photographs, after a process of site recognition, were organised by geographical contexts, subject and period in which they were taken, then catalogued and 'mosaicised' to produce a thorough study of the historical landscape and its subsequent transformations, using the World War I Istituto Geografico Militare (IGM) maps and the maps drawn by the opposing armies to reproduce the military logistics and infrastructures. Then a private company (GeoInfoLab, Olbia) specialising in importing pictures into GIS software built a soon-to-be-launched software tool that takes users on a guided flight over the territory in simulators set up in the project partners' museums and premises. The software tool provides a choice between flights in full autonomy and guided flights along the Venice coast, along the Piave River up to Montello Hill, along the lower reaches of the Isonzo River, and across the city of Treviso, areas that have larger numbers of historical photographs. The main feature required by the experts was to synchronise (vertically and horizontally) the historical and current landscape so as to allow comparison (Figures 16.6 and 16.7).

The project has created an innovative engagement with the historical and cultural heritage represented by the historical aerial photographs, which for the first time can be appreciated synchronically, even though they come from



16.6 A flight simulator frame of the Alisto project. On the left the World War I landscape with some old annotations in red, on the right the present landscape. The menu on the left side enables activation of thematic guided tours and the highlighting of military targets. The control column below allows touch-screen surfing or activation of the joystick, choice of language and visualisation mode on the screen. Courtesy LP Alisto Project



16.7 Flight simulation over the city of Treviso during the war (right) and today (left) with identification dots on the present landscape. The area not covered by the historical photos is depicted through IGM maps. Courtesy LP Alisto Project



16.8 Simulated airborne Austro-Hungarian Lohner (a reconnaissance flying boat produced in Austria-Hungary during World War I). Courtesy LP Alisto Project

widely dispersed archives. In addition, it contributes to the study of the archived historical materials, which often have not been catalogued and are therefore unknown. Agreements with the Archivio Provinciale di Gorizia and the Museo dell'Aeronautica Gianni Caproni in Trento allowed their images to be used free of charge in return for digitisation and acknowledgement of the photographed sites and cataloguing. Moreover, the mosaicing of the images allows a complete view of the historical territory, which has never been seen before, and allows a comparison with the present landscape – these are fundamental prerequisites for future studies in different subjects. This visualisation tool is a useful support for urban development and planning decisions, allowing consideration of historical memory and the evaluation of the impact of new interventions. They are also the basis for any future study of the historical military landscape and in particular with conflict archaeology, an emerging discipline.

To date, with almost 3,000 available aerial reconnaissance photographs, a good coverage of the Piave and Isonzo areas has been achieved, as well as of the coast from Trieste to Grado, the Venetian coast, the Karst plateau and the main cities on the front and the areas behind it. As the research continues in further areas, the software tool can be implemented. Some themed exhibitions have been created within the project, both in Italy and Slovenia, with the aim of enhancing the wealth of unpublished documentation retrieved from aerial reconnaissance, and further researching aerial photographic techniques, the creation of fake landscapes and airfields. The Province of Treviso has also developed educational activities, raising school student awareness of the themes of military landscape and aviation in World War I, by using the project research material. These include:



- a short DVD to provide a direct emotional experience on World War I Italian and Austro-Hungarian air force, the airfields, the aerial photographs and the transformation of the landscape;
- a game about the organisation of an airfield at that time and the geographical distribution of airfields in relation to the transformation of the frontline that aims to assess learning outcomes (Figure 16.9). Here, students have to build an airfield using magnets in the shapes of hangars, planes, different kind of barracks and then on other boards, geographically representative of the different periods of the conflict (Isonzo, Carso and Piave frontline), pupils have to position the airfields and the different kind of aircraft (reconnaissance, fighter, bomber).

16.9 Educational game about the organisation of airfields. Courtesy LP Alisto Project

Conclusion

This chapter and the selected photographs show an excerpt of the material gathered in the course of the research, presenting a method of organising and interpreting the images. This shows the applicability of cutting-edge IT technologies, combining material identified by experienced historians and

landscape architects (Scroccaro and Cuttini), for cultural and tourist usage of historical documents and for the analysis of landscape transformations in north-eastern Italy over the last century. This transformation is particularly evident along the coast, in the courses of the rivers, the lagoon systems, the ports, the industrial and residential centres and the civil and military infrastructures.

The software is not yet operational and therefore its effectiveness and the public's response have not yet been tested. It is a first trial of a specific 4D navigation system (Figure 16.8) instead of a real flight simulator, and the project has demonstrated its feasibility in providing a reading of the historical landscape. It is hoped that further funding will support incorporation of further aerial photographs from other foreign archives, to better organise the iconographic material, to develop graphics and a menu able to support wide historical research. Such development would also aim to show more effectively the detail of the logistics and defensive organisation of the opposing armies and the changes in their disposition during the conflict. Finally, it is hoped to test the use of a real flight simulator to provide real and exciting flight, take-off and landing experiences.

Acknowledgements

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References

- AUSSME = Archivio Ufficio Storico Stato Maggiore dell'Esercito.
- Chiusano, A. and M. Saporiti (1998) *Palloni, dirigibili ed aerei del Regio Esercito* (1884–1923). Roma: Stato Maggiore dell'Esercito – Ufficio storico.
- Cuttini, R. and M. Scroccaro (2014) *Ali sulla storia (Wings on History)*. Cormons (Gorizia): Poligrafiche San Marco.
- del Genio (1917) Memoria del sig. colonnello Penna Cav. Lorenzo (Memoir of Colonel Penna Lorenzo Knight) AUSSME, E1, n.18192 del 27/03/1917 n.°5).
- (1919) Relazione sui mascheramenti (Camouflage Report) AUSSME, E1.
- Di Martino, B. (1999) *Ali sulle trincee. Ricognizione tattica e osservazione aerea nell'aviazione italiana durante la Grande Guerra*. Roma: Stato Maggiore Aeronautica Ufficio Storico.

—— (2011) *L'aviazione italiana nella Grande Guerra*. Milano: Mursia.

Fraschetti, A. (1986) *Prima organizzazione dell'Aeronautica Militare in Italia dal 1884 al 1925*. Roma: Stato Maggiore Aeronautica Ufficio Storico.

Lodi, A. (1976) *Storia delle origini dell'aeronautica militare 1884–1915*, vol. I. Roma: Edizioni Bizzarri.

Porro, F. (1936) *La Guerra nell'aria, terza edizione riveduta e ampliata*. Milano: Corbaccio.

Tardivo, C. (1911) *Manuale di fotografia, telefotografia, topofotografia dal Pallone*. Torino: Carlo Pasta Editore.

Zicavo, E. (1928) *Notizie storiche sulla specialità aerostieri e fotografi del Genio del R. Esercito Italiano*. Roma: Gruppo aerostieri del Genio (tip.).



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The Aerial Perspective in a Museum Context: Above Flanders Fields 1914–1918

Birger Stichelbaut and Piet Chielens

Abstract

During World War I millions of aerial photographs were taken documenting a cultural landscape from which the relicts sometimes remain visible as scars on the landscape. Most often, however, this landscape is preserved beneath the surface as archaeological heritage, invisible to the hundreds of thousands of annual visitors to the Ypres Salient (the frontlines around Ypres) and the local inhabitants of the area. Since 2006 the Department of Archaeology (Ghent University) and the In Flanders Fields Museum have investigated the archaeological potential of these historical aerial photographs. This chapter explains how thousands of these images are now converted into a primary source on their own and are being used to tell the story of World War I in a museum providing a bird's-eye view of the conflict landscape.

Keywords: World War I, museum application, Ypres Salient, conflict landscape, Belgium, In Flanders Fields.

Introduction

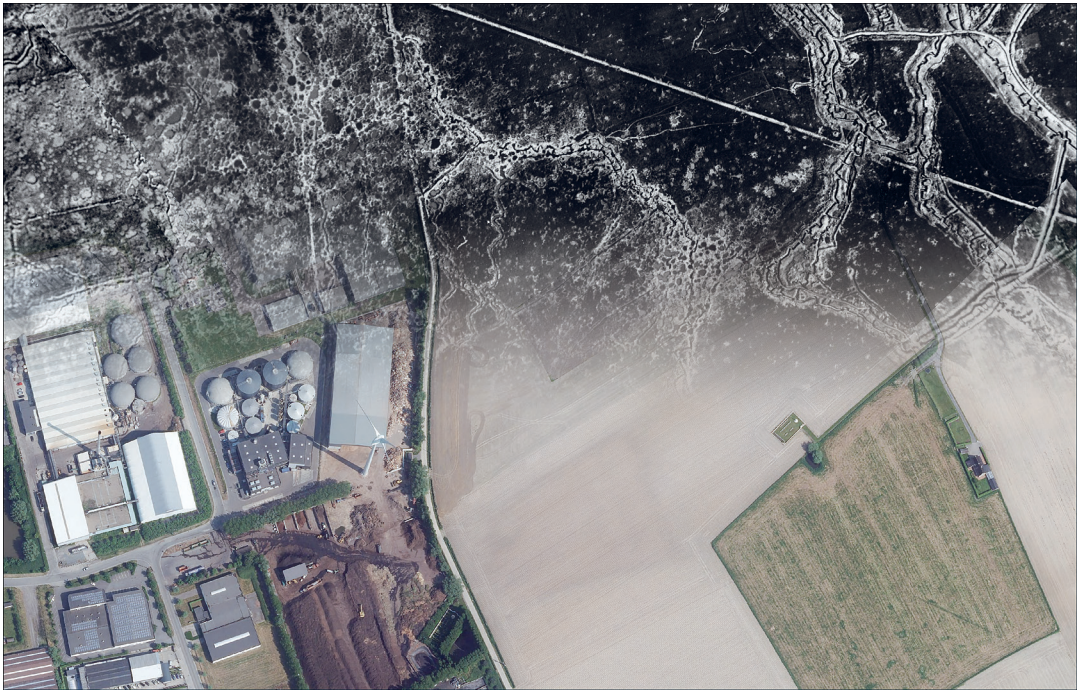
The centennial of World War I (1914–18) has generated an increased public interest in the heritage and landscape of this worldwide conflict. One of the museums dealing with World War I along the former Western Front is the In Flanders Fields Museum (IFFM) in Ypres. The IFFM is a historical museum dealing with diverse aspects of World War I in the West Flanders front region. The relaunch of the permanent exhibition in 2012 sees a focus on the human experience in the war and draws particular attention to the contemporary landscape as one of the last true witnesses of the war.

During the war, millions of aerial photographs were taken by all combatant countries. These provide an unparalleled record of both the progress of the war and the destruction of the landscape. Until recently these remarkable records have only been used as simple illustrations. This chapter explores their role in the design of the In Flanders Fields Museum and two interactive applications. This raises some key questions: How can aerial photographs be used as a narrative of a conflict landscape? What are the limits or the added value of the aerial perspective? And what kind of stories can be told by means of historical aerial photographs?

The Last Witness

In the opening year of the IFFM in 1998, 80 years after the end of World War I, 12 veterans visited the museum and about 65 per cent of the museum visitors had personal contact with the generation who had some personal experience with the war (Stad Ieper 2006). This personal contact ensured that the narrative of the museum could draw on personal and emotional connections of the visitors with the war. In 2012 the museum was completely renewed, addressing the challenges and changing roles of museums in the twenty-first century. Following the opening of the new exhibition, in 2013 a visitor survey (n=535) revealed that for only 28.8 per cent of the visitors was their personal connection with the war a motivator for their visit (In Flanders Fields Museum and Westtoer 2013). Many of the 400,000 annual visitors to the museum, especially the younger generation, might have a family connection to World War I or even the Ypres Salient but never had a personal encounter with the generation who witnessed the war. This illustrates that new ways had to be found to engage with the visitors, draw their attention and tell the story of this violent episode in history and what happened in the front region almost a hundred years ago.

One of these new focus points in the IFFM is the conflict landscape. The trench warfare in the Ypres Salient was heavily influenced by the landscape whose topography dictated where the frontlines and trenches were located. But perhaps even more important from a cultural heritage point of view is that the war also shaped and scarred this landscape. Now that the last living witnesses who experienced the horrors of World War I have died, this war landscape is becoming the real 'last witness' of the conflict (Figure 17.1). In the present-day landscape, there are numerous visible traces of the war. Sometimes these are tangible, such as the hundreds of war monuments and the cemeteries with their distinctive white stones evoking the heavy losses. Dozens of large mine craters, relics of the tunnelling war beneath the surface, are now visible as tranquil and deceptively peaceful pools. Concrete bunkers – often too massive to be destroyed in the post-war years – mark the locations of former trench positions and gun emplacements. However, the reconstruction of the landscape in the years immediately after the war transformed the landscape, erasing many of the surface traces of World War I



and making them invisible to the hundreds of thousands of annual visitors to the Ypres Salient.

The museum explored this aspect for the first time in 2006 with the temporary exhibition 'The Last Witness: The War Landscape of the Ypres Salient' (Chielens 2006). A selection of historical aerial photographs was used in the exhibit to explain key sites in the Ypres Salient and illustrate their landscape context. The same year the underestimated potential of using historical aerial photographs for various applications was highlighted during the international conference 'Images of Conflict: Military Aerial Photography and Archaeology' (Stichelbaut et al. 2009). As a consequence, the IFFM intensified its interest in this domain by collaborating with on-going research at Ghent University (Stichelbaut 2009). In this context, the renewal of the museum was prepared from 2009 onwards.

17.1 Historical aerial photograph on top of a modern day orthophoto. Courtesy of the In Flanders Fields Museum and Orthophoto © Agentschap Geografische Informatie Vlaanderen

World War I Aerial Photographs

After the Battle of the Yser and the First Battle of Ypres in October–November 1914 the war of movement changed into a stalemate in the trenches. The traditional means of gaining intelligence on the enemy such as the cavalry and espionage failed and the newly created air forces soon became the new eyes of the armies (Carlier 1921: 4). The main reason for taking aerial photographs and interpreting these documents was 'to find out the exact nature of enemies' works' and 'to discover the *raison d'être* for these works'

(Grand Quartier Général des Armées 1916). Photo-interpreters 'penetrate the thoughts of the German commander, to live the life of the men holding the trenches, and to foresee the action that they will instinctively take in case of an attack' (de Bissy s.d.: 1). The aerial photographs 'brought visual news from beyond the frontier of natural sight' (Hauser 2008: 34) and 'aerial survey became the most significant development in military cartography during the war' (Chasseaud 2009). When one considers that, a mere decade after the first 12-second flight of the Wright Flyer, aircrews were operating at 1,500 to 6,500 metres above the enemy lines while being targeted by anti-aircraft artillery from the ground and fighter pilots in the sky, one can only be astonished by both the quality and quantity of the results. To the general audience, the importance of photo reconnaissance was always overshadowed by fighter aces such as George Guynemer, William Bishop or Manfred von Richthofen (for example Streckfuss 2009).

Photography is described as 'essentially an act of non-intervention' by the essayist Susan Sontag (1977: 11). This is certainly not the case when it comes to aerial photography. Aerial photographs and more specifically the use of the stereoscope to provide 3D views of the landscape are on the contrary described 'one of the most lethal weapons of the war' in the 1919 magazine *Popular Mechanics* (Douglass Reid quoted in Finnegan 2006), while Kitty Hauser observes that 'images themselves become artillery' (Hauser 2008: 31). Without the aerial photographs there would simply be no targets for the artillery to fire at. An aerial observer described his reflections on his task: 'There was something hugely satisfying however ... to go over the lines and look vertically down on the enemy's most treasured and private property, and to know that you had it in your power to bring its destruction or capture, that was in truth a job worth doing' (Finnegan 2006: 432).

Hundreds of thousands of these World War I aerial photographs have survived in archives all over the world (Beylot 2009, Haupt 2009, Stichelbaut and Bourgeois 2009, Stichelbaut et al. 2010) covering different theatres of war (Western Front in Belgium and France, Eastern Front, Gallipoli, Palestine, Isonzo Front and so on).

Bird's-Eye View of the Western Front

These aerial photographs offer an exceptional bird's-eye view on the landscape of the Western Front. Although millions of images were taken, access to the aerial perspective was restricted to a narrow group of spectators: a military elite of commanders, photo interpreters, map makers and intelligence officers in the hinterland who literally saw and experienced the war from a distance through a new technology of vision. This viewpoint was fundamentally different from the rather limited view a regular foot soldier would have of the battlefields (Saunders 2009: 39).



The power of the elevated viewpoint was already recognised during the war. The famous war photographer Frank Hurley took the opportunity to ascend in observation balloons near Ypres (Dixon and Lee 2011: 22) and the scenery made a strong impression on him: 'The aerial view over the battlefield was inexpressibly wondrous and grand. It is just as one's imagination would photograph it. Although the visibility was bad, the misty atmosphere enhanced the terrible desolation and reality of this artificial hell' (Frank Hurley cited in O'Keefe 1986: 64).

The photographs taken during the war are diverse and show a military landscape stretching over kilometres from the frontlines to far behind the lines and are an excellent archaeological resource (see also [Chapters 1 and 2](#)). A first group of photographs are the oblique or panoramic photographs, which were taken at a shallow angle to the photographed area ([Figure 17.2](#)). These photographs are easy to read – even for an inexperienced observer – because the viewpoint resembles the normal way people perceive their surroundings. It is as if the spectator is looking down from the top of a mountain or from an observation balloon, just as Frank Hurley would have experienced it.

For people unfamiliar with air photo interpretation the vertical perspective is by contrast difficult to read and interpret. The further away the spectator is from the spectrum – the target of the photograph using the terminology

17.2 German oblique aerial photograph (31 October 1917) of the centre of Passchendaele during the Third Battle of Ypres. Only some walls of the church are still standing, the remaining parts of the village are almost invisible as they were pulverised by artillery fire. Less than two weeks later the village was captured and the offensive put to a halt. Courtesy of the In Flanders Fields Museum

of Barthes (1981) – the more abstract and alienated the representation of the landscape becomes. This two dimensional ‘plan’ view of vertical aerial photographs is described by Moshenska as the ‘bombardier’s-eye view’ (Moshenska 2009) and critiqued for ‘the inhuman distance from the humans’, potentially ‘resulting in research that dehumanizes’ the subject (Myers 2010: 462). When it comes to World War I we believe this is only partially true. Many photographs of the front area, especially those taken during and after the Third Battle of Ypres, show a desolate lunar landscape devoid of humans. Nevertheless, the full horror of events on the ground is evident in the disfigured landscape pockmarked with uncountable shell holes. While the flying altitude often does not reveal any living persons to be seen on the military reconnaissance photographs they are undeniably in the landscape, during daylight taking shelter in the trenches and bunkers concealing themselves from aerial observation. On the other hand, the casualties of war are clearly visible. German wartime cemeteries were landscaped using elaborate designs, which to our view can mostly be appreciated from an aerial perspective (see for instance Stichelbaut and Chielens 2013: 110). The progress of military actions and the corresponding underestimation of the expected casualty numbers are revealed because the areas of cemeteries were too small to keep up with the sometimes constant stream of casualties, resulting in clusters of cemeteries next to each other (Stichelbaut and Chielens 2013: 78–9).

Visitors to the In Flanders Fields Museum research centre, or battlefield tourists making a pilgrimage to the Western Front, are sometimes searching for the place where an ancestor went missing or was given temporary burial. If an aerial photograph of that place happens to exist, taken perhaps only a few days or weeks after the date in question, such visitors will often remark that ‘he’s in the picture’, even if an individual grave can hardly ever be discerned, let alone identified. The aerial photographs therefore create an intense feeling of presence in relation to the events that took place and photos can be considered what Susan Sontag describes as ‘both a pseudo-presence and a token of absence’ (Sontag 1977: 16).

In Flanders Earth Application

The renewed permanent exhibition of the IFFM adopts the aerial perspective in several museum displays. Large format oblique photos show the destruction of the landscape in 1918. Aerial photographs are projected in a video presentation explaining the Second Battle of Ypres as seen from a low flying helicopter – the projection screen itself evokes the inside of a tethered observation balloon. And visitors can ascend the belfry tower of the cloth hall to look at the former battlefields on the higher ridges surrounding the town.

During the last decade the aerial perspective has become a part of our visual world with the routine use of applications such as Google Earth and Maps and even integrated into millions of smart phones around the world.

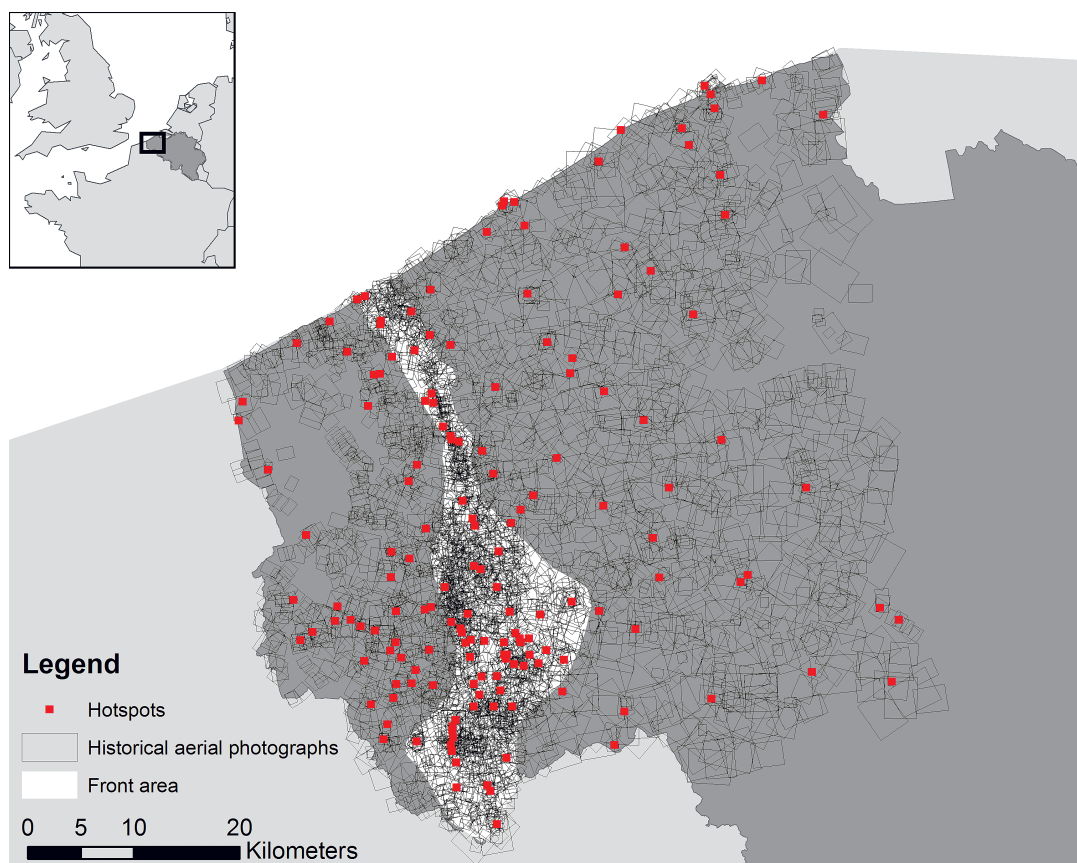


The 'In Flanders Earth' application (IFE) draws on this experience and derives its name from 'In Flanders Fields' and 'Google Earth'. It is essentially an interactive application highlighting the bird's-eye view of the conflict landscape of the war. It uses aerial photographs as a medium to provoke thoughts about the scale and intensity of this war in Belgium.

The application consists of four large multi-touch-screens that visitors can use to explore the war landscape in an interactive and dynamic manner. In between the screens, a section of a tree trunk is exhibited. This oak was planted in 1760 and survived the war. The years of conflict are visible as black marks in the tree rings, underscoring that the traces of war are omnipresent in the fabric of the region and making the oak a powerful symbol of the landscape as the 'last witness' (In Flanders Fields Museum 2012: 14).

The content of IFE draws upon scientific research of over 18,000 aerial photographs that were selected in archives, digitised and georectified in a Geographical Information System (Stichelbaut 2011). From these, 3,496 images were selected for their location, date and photographic quality and included in IFE (Figure 17.3). Ideally, every section of the front area is covered by at least one photograph per war year. For the areas behind the front coverage aimed for at least one high-quality photograph. The application combines a front-end ArcGIS Flex application programming interface linked to a back-end Filemaker database to manage the content. The concept of the application was developed together with the exhibition designer Tijdsbeeld & Pièce Montée and the idea was transformed into a working multimedia device by Kiss the Frog.

17.3 In Flanders Earth installation in the IFFM. Each pillar of the construction contains a large multi-touch tablet. Courtesy of the In Flanders Fields Museum.
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17.4 Overview of historical aerial photographs included in the application and hotspots.
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The interface is inspired by Google Earth and combines three layers of information (Figures 17.4 and 17.5). An important layer is the present-day aerial photo. This is not only the main layer which is used for navigation purposes but it also represents the modern-day landscape in which the war took place and users can explore this to discover heritage sites. A second layer of historical aerial photographs shows the war landscape on a regional scale. The third layer consists of hotspots, marked by large red icons, which are a selection of visually interesting case studies told by a sequence of aerial photographs and other historical documentation.

Visitors can navigate to the area they are interested in by clicking on the inset map, use the integrated address search engine or manually navigate on the present-day aerial photo using multi-touch gestures. On the lower right-hand side of the screen there are constantly updated thumbnails of aerial photographs that lie within the extent of the view. As soon as one clicks on a preview, the aerial photo is projected on the modern-day aerial photo. One can zoom in and look at details of interest or can compare photographs of different dates. This functionality shows the textures of an industrialised war, the gradual destruction of villages and towns and the extensive networks of trenches running like veins through what is essentially



a messy landscape (Mlekuž 2012: 23). David Collard – commenting on a series of recently published 1914–18 aerial photographs (Stichelbaut and Chielens 2013) – observes:

most vividly represented is the inexorable degradation of the countryside as the conflict unfolds. The earth is pitted and pulverized, entire forests bombed into nothingness, every building razed. There's not a blade of grass to be seen, only mud and rubble, the scribbled lines of trenches, flooded craters and thickets of barbed wire, a barren, waterlogged necropolis. (Collard 2014: 11)

To allow the visitor to compare the modern-day and the war landscape a transparency slider is included. Visitors can blend the historical photograph with the modern-day landscape and engage in dialogue with the virtual landscape. The green fields suddenly become scarred with lines of trenches, railways, craters and thousands of shell holes. Often it is very shocking to see the scale and the intensity of war on the landscape. This part of the application is mainly aimed at the local population and the well prepared visitor who has a personal connection to places in the Ypres Salient.

Just as photo-interpreters need training to extract meaningful information from the aerial photographs, visitors need a key to understand the patterns, shapes, textures and events recorded in the imagery. The long-distance views provided by the aerial photographs are supplemented by short captions, historical data, ground photographs and oblique aerial photographs in 166 'hotspots'. These are short, visual narratives and provide additional interpretive content. Many hotspots focus on diverse aspects of the stalemate in the trenches showing the effect of small-scale actions, explaining the mining war below the surface, providing before/after views of artillery shelling or

17.5 Interface of In Flanders Earth. With (a) inset map, (b) address search engine, (c) historical aerial photograph, (d) historical ground photograph, (e) site, (f) 'hotspot', (g) transparency slider and (h) previews of historical aerial photographs within the extent of the screen. Courtesy of the In Flanders Fields Museum

illustrating military engagements such as the Battle of Messines and the Third Battle of Ypres. To emphasise the depth of the military layer of the landscape many hotspots also focus on sites in the hinterland illustrating, for instance, airfields, hospital sites, the gradual expansion of cemeteries, submarine bases, naval infrastructure or coastal defences.

Observation of visitor interaction with the application shows that there are multiple levels of users. Some only quickly look at the screen, while others spend up to 10 minutes exploring the landscape and studying sites in detail. The interactive aspect of the application attracts school children and the transparency slider is a much-used functionality. The application is appreciated by the visitors, with visitor surveys showing that 6.2 per cent of the individual visitors regard the IFE as the most impressive part of the museum (In Flanders Fields Museum and Westtoer 2013: 46–7).

Future Perspective

In Flanders Earth literally brings the landscape into the museum, but the application is also an encouragement to go out and experience the landscape. For younger visitors the engagement with the wartime landscape can be as important and overwhelming as the personal encounters the older generation had with living witnesses of World War I. Today, more than half of the visitors extend their museum trip with a visit to at least one site in the landscape (In Flanders Fields Museum and Westtoer 2013: 36). One of the challenges of the In Flanders Fields Museum is to explain the importance of the landscape as the last witness and make the war layer and archaeology of the conflict legible in the landscape.

In 2015 the In Flanders Fields Museum and the City of Ypres recently opened three additional visitor facilities in the Ypres Salient itself. The objective is that after seeing the landscape in the museum visitors can go out and experience the multilayered conflict landscape informed by a polyphony of witnesses (poetry, historical documents, photographs, personal stories, archaeology and monuments). Moreover, mobile applications provide museums with the opportunity to offer a visitor content which cannot be delivered with traditional prints or brochures (Gammon and Burch 2008: 35). Within the framework of the European project Archaeolandscapes a mobile app ('Ypres Salient 1914–1918') is currently being developed and is to be launched in May 2015. Visitors will explore the landscape in a number of walking routes guided by mobile devices featuring historical aerial photographs in combination with their position on the photograph. They will be able to walk on top of the trenches, see and experience how close the enemy frontlines were located to each other and be able to cross no man's land – all in a landscape where the vast majority of the visible surface expressions of the war have long-since been buried. The use of this technology also prevents the over-museification of the landscape with a proliferation of interpretation panels.

Conclusion

With the disappearance of the generation who lived through World War I a direct engagement with the war through people is no longer possible, and here the places where the war once raged provides a mechanism to generate connections and engagement. The aerial photographs offer a way of bringing the landscape in to the museum and also bring museum methods to the landscape by mobile devices. The combination of modern technology and historical imagery gives the aerial photographs a new meaning. The photos are no longer restricted military intelligence data. Instead of providing strategic data to photo-interpreters, they now inform visitors and inhabitants of conflict landscapes on a much larger scale.

This collaborative project is also an example of how scientific research can, and should, have a public outreach. Instead of reaching limited numbers of researchers through specialised publications now hundreds of thousands of visitors are reached each year.

References

- Barthes, R. (1981) *Camera Lucida*. New York: Hill and Wang.
- Beylot, A. (2009) Military Aerial Photographs, from 1914 to the Present: A Survey of the French Sources. In B. Stichelbaut, J. Bourgeois, N.J. Saunders and P. Chielens (eds) *Images of Conflict: Military Aerial Photography and Archaeology*, pp. 135–50. Newcastle-upon-Tyne: Cambridge Scholars Publishing.
- Carlier, A. (1921) *La photographie aérienne pendant la guerre*. Paris: Librairie Delagrave.
- Chasseaud, P. (2009) Imaging Golgotha: Photogrammetry on the Western Front, 1914–18. In B. Stichelbaut, J. Bourgeois, N.J. Saunders and P. Chielens (eds) *Images of Conflict: Military Aerial Photography and Archaeology*, pp. 87–120. Newcastle-upon-Tyne: Cambridge Scholars Publishing.
- Chielens, P. (2006) De laatste getuige. Het landschap meer dan ooit. In P. Chielens, D. Dendooven and H. Decoodt (eds) *De laatste getuige. Het landschap van Wereldoorlog 1 in Vlaanderen*, pp. 9–11. Tiel: Lannoo.
- Collard, D. (2014) Visible Scars: An Aerial Overview of the Bloodiest Archaeological Sites in the World. Book review *The Great War Seen from the Air*. *Times Literary Supplement* 5809: 11.
- de Bissy, J. (s.d.) *Illustrations to Accompany Captain de Bissy's Notes Regarding the Interpretation of Aeroplane Photographs*. S.l.: s.n.
- Dixon, R. and C. Lee (eds) (2011) *The Diaries of Frank Hurley, 1912–1941*. London: Anthem Press.
- Finnegan, T. (2006) *Shooting the Front. Allied Aerial Reconnaissance and Photographic Interpretation on the Western Front – World War I*. Washington DC: National Defence Intelligence College Press.

- Gammon, B. and A. Burch (2008) Designing Mobile Digital Experiences. In L. Tallin and K. Walker (eds) *Digital Technologies and the Museum Experience: Handheld Guides and Other Media*, pp. 35–63. Lanham, MD: AltaMira Press.
- Grand Quartier Général des Armées (1916) *Notes sur l'interprétation des photographies aériennes*. S.I.: s.n.
- Haupt, P. (2009) Great War Aerial Photographs in German Archives: A Guide to the Sources. In B. Stichelbaut, J. Bourgeois, N.J. Saunders and P. Chielens (eds) *Images of Conflict: Military Aerial Photography and Archaeology*, pp. 151–64. Newcastle-upon-Tyne: Cambridge Scholars Publishing.
- Hauser, K. (2008) *Bloody Old Britain: O.G.S. Crawford and the Archaeology of Modern Life*. London: Granta Books.
- In Flanders Fields Museum (2012) *Educational Package In Flanders Fields Museum*. Ieper: In Flanders Fields Museum.
- In Flanders Fields Museum and Westtoer (2013) *Evaluatie van het nieuwe In Flanders Fields Museum. Tabellenrapport, januari 2013*. Ieper: IFFM.
- Mlekuž, D. (2012) Messy Landscapes Manifesto. *AARGnews* 44: 22–3.
- Moshenska, G. (2009) Resonant Materiality and Violent Remembering: Archaeology, Memory and Bombing. *International Journal of Heritage Studies* 15(1): 44–56.
- Myers, A. (2010) Camp Delta, Google Earth and the Ethics of Remote Sensing in Archaeology. *World Archaeology* 42(3): 455–67.
- O'Keefe, D. (1986) *Hurley at War: The Photography and Diaries of Frank Hurley in the Two World Wars*. Broadway, NSW: The Fairfax Library.
- Saunders, N.J. (2009) Ulysses' Gaze: The Panoptic Premise in Aerial Photography and Great War Archaeology. In B. Stichelbaut, J. Bourgeois, N.J. Saunders and P. Chielens (eds) *Images of Conflict: Military Aerial Photography and Archaeology*, pp. 27–40. Newcastle-upon-Tyne: Cambridge Scholars Publishing.
- Sontag, S. (1977) *On Photography*. New York: Anchor Books.
- Stad Ieper (2006) *Tentoonstelling De laatste getuige*. <http://www.ieper.be/default.aspx?SGREF=98&CREF=14703> (retrieved 17 November 2014).
- Stichelbaut, B. (2009) *World War One Aerial Photography: An Archaeological Perspective*. Unpublished PhD. Ghent: Department of Archaeology UGent.
- (2011) The First Thirty Kilometres of the Western Front 1914–1918: An Aerial Archaeological Approach with Historical Remote Sensing Data. *Archaeological Prospection* 18(1): 57–66.
- Stichelbaut, B. and J. Bourgeois (2009) The Overlooked Aerial Imagery of World War One: A Unique Source for Conflict and Landscape Archaeology. *Photogrammetrie – Fernerkundung – Geoinformation* 3: 231–40.
- Stichelbaut, B., J. Bourgeois, N.J. Saunders and P. Chielens (eds) (2009) *Images of Conflict: Military Aerial Photography and Archaeology*. Newcastle-upon-Tyne: Cambridge Scholars Publishing.
- Stichelbaut, B. and P. Chielens (2013) *The Great War Seen from the Air: In Flanders Fields: 1914–1918*. Brussels: Mercator Fonds.
- Stichelbaut, B., W. Gheyle and J. Bourgeois (2010) The Imperial War Museum's Box Collection. In R.A. Standring, D.C. Cowley and M.J. Abicht (eds) *Landscapes Through the Lens: Aerial Photographs and the Historic Environment*. Occasional

Publication of the Aerial Archaeology Research Group No. 2, pp. 225–36. Oxford and Oakville, CT: Oxbow Books.

Streckfuss, J. (2009) Why the Air War Really Mattered: A Guide to Understanding the Significance of Aviation in World War I. In B. Stichelbaut, J. Bourgeois, N.J. Saunders and P. Chielens (eds) *Images of Conflict: Military Aerial Photography and Archaeology*, pp. 41–54. Newcastle-upon-Tyne: Cambridge Scholars Publishing.



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Index

References to illustrations are in **bold**.

- aerial photography
 - accessibility [7](#)
 - Adelaide River case study, Australia
 - Northern Territory [175](#), [176](#), [176](#), [177](#)
 - ‘Anzac from the Air’ display [258–9](#), [259](#)
 - Australia [173–4](#)
 - Darwin [168](#)
 - development [254](#), [266](#), [267](#)
 - England
 - Home Front [74–87](#)
 - sources [76](#), [78](#)
 - Flanders [286](#), [287](#)
 - Gallipoli battlefields [254](#), [255](#), [256](#)
 - Głogów, Poland [222–3](#)
 - and heritage protection [79–80](#)
 - and hot-air balloons [266](#)
 - interpretation problems [266–8](#)
 - Italy
 - Emilia Romagna [206](#)
 - Udine [266](#)
 - unexploded ordnance [210–16](#)
 - World War I [266](#) [266](#), [267](#), [267](#), [271](#)
 - La Boisselle battlefield [49](#), [50](#)
 - and landscape camouflage [268](#), [269](#), [270](#)
 - and mapping [80](#), [81–2](#)
 - munitions storage, northwest France [198](#), [200](#)
 - Normandy Campaign [187](#)
 - northwest France
 - Bois Carré V-weapon site [194](#)
 - Cagny air raid [190–91](#)
 - Conches-en-Ouche airfield [195](#)
 - La Chapelle-en-Juger air raid [193](#)
 - Passchendaele [283](#)
 - Poland
 - Miedzianka [229–30](#)
 - Ostrawa [230](#), [231](#), [232](#)
 - Seaford, World War I training camps [82](#), [83](#), [83](#), [84](#), [84](#)
 - stereoscopy [267](#)
 - World War I [281–2](#), [283–4](#), [283](#)
 - Ypres Salient [281](#)
 - see also* [Britain from Above project](#)
- aerial warfare
 - England [74](#)
 - Scotland [63](#)
- Aerofilms Collection
 - contents [78](#)
 - Scotland [60–61](#)
- AFN (Aerofototeca Nazionale),
 - photographic archive [205](#), [206](#)
- Airborne Laser Scanning, *see* [ALS](#)
- airships
 - Scotland [63](#)
 - Lenabo airship station [64](#)
- Allen Collection, Ashmolean Museum [78](#)
- ALS (Airborne Laser Scanning) [1](#), [2](#), [5](#), [7](#), [57](#), [82](#)
- Czechoslovakia, Tachov Region [243–4](#), [246](#)
- Ireland [94–5](#)
 - Randalstown Training Camp [96](#), [97](#), [98](#), [99](#), [100](#), [102](#), [104](#)
- LiVT (LiDAR Visualisation Toolbox) [98](#)
- Poland
 - Eastern Front [150](#), [151](#), [158](#), [159](#), [164](#)
 - Ostrawa [230](#)

- RVT (Raster Visualisation Toolbox) 98
- Slovenia, Soča Front battlefields 130, 131, 132, 135–6, 136, 138, 143
- use of 128
- ‘Anzac from the Air’ display; *see under* Australian War Memorial
- ArchaeoLandscapes Europe project 4
- archaeology, palimpsest concept xxx, 2, 132; *see also* conflict archaeology; landscape archaeology
- Armistice Day 3
- Ashmolean Museum, Allen Collection 78
- Australia
- aerial photography, collections 173–4
- National Archives of 173
- National Trust 172
- Australia Northern Territory
- Adelaide River case study 174–81
- aerial photography 175, 176, 176, 177
- GIS mapping 179, 180
- Snake Creek 177, 178, 179, 180
- surface remains 177
- War Cemetery 176, 180
- World War II
- interpretation panel 171
- key sites, map 172
- militarisation 169–70
- Stuart Highway 172, 173, 174
- see also* Darwin
- Australian Historical Mission (1919), Gallipoli battlefields 110–11
- Australian War Memorial
- ‘Anzac from the Air’ display 6, 253–62
- aerial photography 258–9, 259
- concept 257–8
- content 254
- design 259
- interactivity 259, 260, 260
- landscape 257–8
- navigation interface 261
- origins 255
- terrain model 260, 261
- touch-screen technology 257, 261, 262
- visitor feedback 261–2
- ‘Australia in the Great War’ galleries 256, 257, 257
- Australian War Records Section 255, 256, 256
- Austro-Hungarian Army 137
- Bean, Charles 110–11, 120, 254
- Bellewaarde Ridge
- aerial, geophysical survey, comparison 35, 42
- archaeology 38, 39, 41
- Battle, fatalities 32
- communication trenches 33, 34, 39
- craters 37
- fire-trench 38, 39, 39
- German shelter, connected to a trench 41
- German trench, wickerwork 40
- historical context 29, 31, 32
- memorial site 42
- mine warfare 33, 35–6, 37–8
- survey 29–42
- trial trenching 32, 38, 39
- underground war, visible remains 36, 38
- view 30
- Berlin Wall, research on 236
- Britain from Above project 73, 78
- Brunner Mond and Company
- Limited building 85, 86
- public input 85, 86
- Cambridge University Collection of Air Photography 76
- Cannock Chase area 82
- Charles Pulman Collection 78
- Cold War, archaeology 235–6
- Comines-Warneton survey
- aerial photographs
- and geophysics 24–5
- historical 14
- geophysical survey 13, 14, 23
- GIS inventory 14
- gun emplacements 18–19, 20, 20, 21, 21, 22
- historical context 13
- hospital sites 15, 15, 16, 18
- Lancashire Cottage Cemetery, evolution 16, 17
- location 12, 13
- military cemeteries 15–16, 15
- Strand Military Cemetery 16, 18, 18
- see also* Plus Douve field
- conflict
- and remembrance 3
- study of xxvi
- and aerial images xxix–xxx
- see also* warfare

- conflict archaeology
 - aerial images 6
 - prospects 7–8
 - scope 1–2
- conflict landscapes
 - features 128, 140, 142
 - Ypres Salient 280, 281
- Council for British Archaeology 84, 85
- Crawford Collection, English Heritage Archive 78
- Cuban Missile Crisis (1962) 236
- Cultural Heritage Management (CHM) 95, 181
- Curtin, John 168
- Czechoslovakia
 - Velvet Revolution (1989) 239, 245
 - Warsaw Pact invasion (1968) 236
 - see also Tachov Region
- D-Day landings 186
- Darwin
 - aerial photograph (1944) 168
 - bombing of 169
 - commemoration 170
 - ‘Defence of Darwin’, interpretation centre 170
- Defence of Darwin Experience 169
- Depth of Investigation (DOI) 23
- DTM (Digital Terrain Model) 98
 - Soča Front battlefields, Slovenia 132, 133
- Easter Rising, Ireland (1916) 187
- Eastern Front (Poland) 6
 - ALS 150, 151, 158, 159, 164
 - casualties 148
 - gas attacks 151–3, 160
 - ‘Gas Regiment’, memorial 154
 - ‘gas-scape’ 153, 156–64
 - archaeological cognitive process 156
 - depositional processes 156
 - map 149
 - post-depositional processes 153, 156
 - pre-depositional process 156
 - robbery pit 163
- ISOK Project 164
- Joachimów-Mogily War Cemetery 157, 158, 158, 159, 163
 - artistic spectacles 160–61
 - burials 160
 - commemoration site 161
 - entrance 162
 - mausoleum 160
- ruined forest 153, 155
- war landscape 155
- Edinburgh, World War I, defences 67, 68
- Ekins, Ashley 257–8
- EMI (Electromagnetic Induction Sensor)
 - features 23
 - fields surveyed with 13
 - La Boisselle battlefield 46
 - Plus Douve survey 23
 - use 25–6
- England
 - aerial warfare 74
 - Aston Down airfield 76, 77
 - Cherry Hinton, training trenches 76, 77
 - Cliffe Explosives Works, remains 75–6, 75
 - Home Front, aerial photography 74–87
 - English Heritage Archive 76
 - Crawford Collection 78
- Flanders
 - aerial photography 286, 287
 - archaeological inventory 31
 - excavations 11
 - In Flanders Earth (IFE), application 4, 285, 285, 287
 - In Flanders Fields Museum (IFFM) 4, 279–80
 - trial trenching 31
 - World War I remains 32
- Flemish Heritage Agency 31
- Forth Bridge, Coastguard Battery 62
- France (northwest)
 - aerial bombing landscapes 188–202
 - airfield sites 194, 195, 195, 196, 197
 - Bois Carré V-weapon site
 - aerial photography 194
 - air raid 194
 - Cagny air raid 189
 - aerial photography 190–91
 - case study sites, map 189
 - Conches-en-Ouche air raid 195
 - aerial photography 195
 - La Chapelle-en-Juger air raid 190, 192
 - aerial photography 193
- Maintenon
 - aerial photography 197, 198
 - air raid 198

- munitions storage 196–9
 - aerial photography 198, 200
 - research possibilities 199, 201–2
 - see also* D-Day landings; Normandy Campaign
- Gallipoli battlefields
 - aerial photography 254, 255, 256
 - ancient historical context 110
 - Anzac area 113, 114, 115
 - archaeological survey 110
 - Australian Historical Mission (1919) 110–11
 - sketch map 112
 - casualties 110
 - GIS survey 112
 - landscape development 123
 - Lone Pine area 116, 117, 118, 118, 119
 - cemetery and memorial 120, 121, 122
 - Ottoman Turkish maps (1916) 120, 121
 - survey methodology 115–16
 - tourism 115
 - trench systems 121, 255
- Gallipoli Peace Park 110
- Gallipoli Peninsula
 - Historical National Park, establishment (1973) 115
 - RNAS floatplane 255
- gas attacks
 - Eastern Front (Poland) 151–3, 160
 - Ypres 152
- Geluveld Plateau 30
- GIS (Geographical Information Systems) 8, 68, 80
 - aerial photography, Gallipoli battlefields 112
 - In Flanders Fields Museum (IFFM) 285
- Głogów (Glogau)
 - aerial photography 222–3
 - city centre) 222
- Google Earth xxix, 6, 179, 284, 285, 286
- GPR (Ground Penetrating Radar) 46, 48, 51, 53, 54, 55, 56, 115
- Greenham Common Peace Camp, UK 235
- Gretna, Scotland (1929) 65
- Gumbinnen, Battle (1914) 148
- Hadrian's Wall, aerial photography, mapping 80, 81
- heritage protection, and aerial photography 79–80
- Holocaust Memorial Day 3
- Home Front Legacy 1914–18 project 85
- Horizontal Coplanar Dipole Mode (HCP) 23
- Hraničky village 247
- Humin, Battle (1915) 149
- Huntington, Samuel P. 221
- Hurley, Frank 283
- ideology, definition 221
- IFFM (In Flanders Fields Museum) 279–80
 - future development 288
 - GIS 285
 - In Flanders Earth (IFE), application 4, 285, 285, 287
 - renewal 281
 - research centre 284
 - visitor numbers 280
- IGN (Institut Géographique National) 186–8
- Ireland, World War I
 - ALS 94–5
 - archaeological investigation 93, 94, 96
 - Easter Rising (1916) 104
 - historiography 94
 - research organizations 94
 - training camps 92, 93
 - trench systems 92, 94
 - see also* Randalstown Training Camp
- Iron Curtain, origins 239; *see also* under Tachov Region
- ISOK Project, Eastern Front (Poland) 164
- Italy
 - bombing of 206–7
 - casualties 207
 - tonnage 207, 208
 - Emilia Romagna, aerial photography 206
 - unexploded ordnance (UXO)
 - active 209
 - aerial photography 210–16
 - bomb craters 211, 212, 213, 214
 - casualties 209
 - tonnage 207, 209
 - World War I, aerial photography 266, 266, 267, 267, 271
- Italy-Slovenia ALISTO project 270–76
 - airfields, educational game 274, 275, 275
 - landscape transformations 272, 273–4, 274

- objective 270
- World War I/contemporary photos, comparison 271
- Joachimów-Mogily War Cemetery; *see under* Eastern Front (Poland)
- Kaczmarek, Krzysztof 160
- Keegan, John xxv–xxvi
- Kitchener's New Army 92
- KOCSA (Key terrain, Observation, Cover and concealment Obstacles), Soča Front battlefields, Slovenia 134
- La Boisselle battlefield
 - aerial photographs 49, 50
 - EMI survey 46
 - geophysical survey 46
 - aerial photographic interpretation, comparison 56
 - equipment 51
 - GPR survey 53, 54, 54, 55, 55, 56
 - gradiometer survey 51, 52, 53
 - historical context 48–9
 - location 46, 47, 48
 - mine warfare 46, 49
 - survey area 47–8
 - trenches 48, 49, 50
 - tunnel system 45, 49
- La Boisselle Study Group 46, 48
- landscape
 - change, Tachov Region 236–9
 - decoy 269, 270
 - embodied perspective 140
 - force of 164
 - memorial 140
 - in Soča Front battlefields, Slovenia 132
 - and warfare 6, 74, 75
 - see also* conflict landscapes
- landscape archaeology 2
 - non-invasive 26
- landscape camouflage
 - and aerial photography 268, 269, 270
 - camouflaged road 270
 - hay barn hiding gun emplacement 269
- Lausanne, Treaty (1923) 110, 111
- LiVT (LiDAR Visualisation Toolbox) 98
- Ludendorff, E., Gen 151–2
- McWilliams, Anna 236
- magnetometry 46, 48, 51
- Malraux, André, 'Lazarus' 161
- Maximilian I, Holy Roman Emperor xxx
- Messines Ridge
 - Battle (1917) 13, 19, 21, 288
 - mine warfare 36, 38
- mine warfare
 - Bellewaarde Ridge 33, 35–6, 37–8
 - La Boisselle battlefield 46, 49
 - Messines Ridge 36, 38
- Mussolini, Benito, World War I diary 143
- National Heritage Protection Plan 79–80, 81
- Normandy Campaign 185, 186, 188
 - aerial photographs 187
 - airfield sites 194–6, 195
- palimpsest concept, archaeology xxx, 2, 132
- Passchendaele 41
 - aerial photography 283
- Peace Camps, UK and USA 235–6
- Perpendicular Dipole Mode (PRP) 23, 24
- Plus Douve field 13, 14
 - EMI survey 23
 - prospection results 19, 23–4, 23, 25
- Poland (Western)
 - landscape transformations 224–33
 - map 220
- Miedzianka
 - aerial photography 229–30
 - copper mining 226
 - destruction of 228
 - tourism 226
 - uranium mining 228
- Ostrawa
 - aerial photography 230, 231, 232
 - ALS view 230, 232
 - destruction 230, 231
- 'regained territories' 223–4
 - cultural landscape 224
- Stargard
 - city centre (1938) 225
 - city centre (1977) 227
 - cultural continuity, breaking of 226
 - destruction by Red Army 226
 - see also* Eastern Front (Poland); Głogów

- RAF Leuchars, Scotland 63
- Randalstown Training Camp (Ireland)
- 3D landscape view 100
 - ALS data 96, 97, 98, 99, 100, 102, 104
 - and aerial photographs 97
 - buildings 100, 101
 - case study 95–105
 - methodology 97–8
 - problems 98
 - results 100–103
 - Command Depot, redesignation 96
 - construction 95
 - facilities 100
 - future research 104
 - location 95, 96, 99
 - maps (1915) 98
 - sub-camps 95, 101, 101
 - trench features 101, 103–4, 103
- Rawka and Bzura, Battle (1914–15) 148, 149, 151
- remembrance, and conflict 3
- remote sensing, *see* ALS
- Rennenkampf, Paul von, Gen 148
- RVT (Raster Visualisation Toolbox) 98
- Salisbury Plain Training Area, training trenches 78, 94
- Scotland
- aerial warfare 63
 - Aerofilms Collection 60–61
 - airships 63
 - Lenabo airship station 64
 - coastal defences 61, 62, 63
 - Cromarty Battery 69
 - drill halls 61
 - Invergordon, Royal Navy site 63
 - Museum of Flight 61
 - naval sites 63
 - RAF Leuchars 63
 - trench system, Cromarty Firth 70
 - World War I 59–60
 - beach trenches 67, 67
 - field defences 65, 66, 67, 67
 - manufacturing 63
 - Zeppelin raid (1916) 67
 - see also* Edinburgh
- Seaford, World War I training camps 82, 83, 83, 84, 84
- Shane's Castle, *see* Randalstown Training Camp
- Slovenia, Soča Front battlefields 127–43, 128
- ALS survey 130, 131, 132, 135–6, 136, 138, 143
 - 'avenues of approach' 139
 - caverns 140, 141
 - combatants 130
 - DTM 132, 133
 - field survey 139–40
 - historical context 128–30
 - KOCHOA analysis 134
 - Koritnica gorge 134, 135
 - landscape
 - hostility of 142
 - materiality of 132
 - obstacles 139
 - Rombon battlefield 136, 137, 139
 - trenches 136–7, 136, 138, 139, 141, 142
 - see also* Italy-Slovenia ALISTO project
- Somme, Battle (1916) 49
- Sontag, Susan 284
- Stonehenge, and World War I aerodrome 78, 79
- Tachov Region (Czechoslovakia)
- ALS use 243–4, 246
 - Border Guard structures 242, 245
 - demolitions 237–8, 240
 - depopulation 237
 - field fortifications 240, 242
 - Iron Curtain 238, 239–40
 - case study 246–50
 - fencing 247, 248–9, 249, 250
 - visual references 241
 - Jedlina village 246–7
 - landscape change 237–40, 250–51, 250
 - non-destructive research 245–6
 - pillboxes 242, 242
 - transfer to Germany (1938) 237
 - trench systems 243–5
- Tannenberg, Battle (1914) 148
- trench systems
- Gallipoli battlefields 121, 255
 - Tachov Region 243–5
 - World War I 12, 13, 24–5
 - see also* trial trenching
- trial trenching
- Bellewaarde Ridge 32, 38, 39
 - Flanders 31
- tunnel system, La Boisselle battlefield 45
- Turin, aerial bombing 207
- Udine, aerial photography 266
- UXO (unexploded ordnance); *see under* Italy

warfare

- artefacts [xxv](#), [xxvi](#)
- and landscape [6](#), [74](#), [75](#)
- material culture of [xxv](#)
- nature of [xxv](#)

Western Front [5](#), [282](#)

- extent [12](#)

Spring Offensive (1918) [13](#), [16](#)

see also [Comines-Warneton survey](#)

World War I [3](#)

- aerial photography [281–2](#), [283–4](#), [283](#)

see also [Western Front](#)

World War II, aerial reconnaissance,
role [205](#)

Ypres

First Battle (1914) [16](#), [29](#), [281](#)

- frontline [30](#)

gas attacks [152](#)

Salient [13](#), [32](#), [36](#)

Second Battle (1915) [29](#), [284](#)

- frontline [30](#)

Third Battle (1917) [36](#), [41](#), [283](#), [284](#),
[288](#)

Ypres Salient

- aerial photography [281](#)

conflict landscape [280](#), [281](#)

Yser, Battle (1914) [281](#)